

SYSTEMS, DEVICES, AND METHODS FOR MANAGING A HEARING AID**Technical Field**

[0001] The present disclosure relates generally to hearing aids, and more specifically, to systems, devices, and methods for managing hearing aids.

Background

5 [0002] Conventionally, hearing aids are inserted into and/or around the auditory canal of a user suffering hearing loss. While such conventional hearing aid technologies have been effective in providing users with improved hearing, it is recognized in the present disclosure that use of such conventional hearing aid technologies oftentimes result in problems, such
10 as ear infections, etc., and generally require regular, periodic, and/or ongoing manual adjustments, tuning, calibrations, and/or re-calibrations to the hearing aid by medical professionals, technical experts, etc.

[0003] Recent advancements to hearing aid technologies have resulted in other approaches, such as bone conduction technology, etc., which no longer requires a part of the hearing aid
15 to be inserted into the auditory canal of the user. While bone conduction technologies have overcome the problem of ear infections, due to diverse and/or varying surroundings (e.g., varying surroundings such as quiet surroundings at home or in an office setting; meetings in which there are oral discussions over a quiet meeting room setting; louder and/or variations/mixtures of varying sounds at a market, mall, and/or other public settings; etc.),
20 such approaches suffer other similar problems encountered in conventional "in-the-ear" hearing aids, including, but not limited to, the need to perform regular, periodic, and/or ongoing manual adjustments, tuning, calibrations, and/or re-calibrations by medical professionals, technical experts, etc. It is recognized in the present disclosure that such adjustments are not only difficult, time consuming, and requires the user to expend recurring
25 costs for such visits, but are also unable to accurately adjust to specific environments that the user will find himself/herself in.

Brief Summary

[0004] Present example embodiments relate generally to systems, devices, and methods for managing hearing aids. For instance, embodiments are directed to systems and methods for
30 adjusting a hearing aid adaptively, dynamically, and/or based on user feedback. In terms of adaptive and/or dynamic adjustments, present example embodiments perform hear aid

adjustments in real-time or near real-time, and based on one or more considerations, including real-time audio (or sound, which are used interchangeably herein) surrounding, existing, and/or within a vicinity, area, or surrounding (or threshold distance) of a user, the user's hearing aid, the user's mobile device, historic information, etc.

- 5 [0005] In a first embodiment, a hearing aid system is described. The system can be applied in-bone conduction hearing aid technologies, in-the-ear hearing aid technologies, and/or a combination of both of these technologies. In an exemplary embodiment, the system includes a hearing aid assembly (e.g., a bone conduction hearing aid) and a processor (also referred to herein as a main processor; e.g., a user's mobile device, a central processor, cloud computing, etc.).
- 10 The hearing aid assembly includes a hearing aid transceiver assembly. The hearing aid transceiver assembly is configurable or configured to selectively emit audio signals to the user (e.g., based on instructions received from a main processor). The hearing aid transceiver assembly is also configurable or configured to obtain surrounding audio information. The surrounding audio information may include real-time surrounding audio-
- 15 related information (e.g., audio-related information of a surrounding environment of the user and/or the hearing aid assembly). The hearing aid assembly also includes the main processor. The main processor is in communication with the hearing aid assembly. The main processor includes an audiometric processor. The audiometric processor is configurable or configured to perform an audiogram generation process. The audiogram
- 20 generation process includes receiving, from the hearing aid transceiver assembly, the surrounding audio information. The audiogram generation process also includes sending, to the hearing aid transceiver assembly, a command to perform an audiometry test on the user. The audiogram generation process also includes receiving, from the hearing aid transceiver assembly, audiometry test results when the audiometry test on the user is
- 25 performed. The audiogram generation process also includes generating an audiogram for the user based on the received audiometry test results for the user. The audiogram generation process also includes generating an initial compression ratio for the user based on the generated audiogram for the user. The audiogram generation process also includes generating a predicted compression ratio for the user based on the generated initial
- 30 compression ratio. The main processor also includes a compression ratio tuner processor. The compression ratio tuner processor is configurable or configured to perform a subsequent test for the user. The subsequent test includes applying the generated predicted compression ratio for the user to the surrounding audio information. The compression ratio tuner

processor is configurable or configured to receive, from the user, subsequent test results for the user based on the subsequent test for the user. The main processor also includes a feedback control processor. The feedback control processor is configurable or configured to generate an optimized predicted compression ratios for the user based on the subsequent
5 test results. The feedback control processor is configurable or configured to apply the optimized predicted compression ratio for the user to the hearing aid assembly.

[0006] In yet another exemplary embodiment of the first embodiment, a hearing aid system is described. The system includes a hearing aid assembly. The hearing aid assembly is configured to be securable to a user. The hearing aid assembly includes a hearing aid
10 transceiver assembly. The hearing aid transceiver assembly is configurable or configured to selectively emit audio signals to the user based on instructions received from a main processor. The hearing aid transceiver assembly is also configurable or configured to obtain surrounding audio information, the surrounding audio information including real-time surrounding audio-related information of a surrounding environment of the hearing aid
15 assembly. The hearing aid assembly also includes a main processor. The main processor is in communication with the hearing aid assembly. The main processor includes an audiometric processor. The audiometric processor is configurable or configured to perform an audiogram generation process. The audiogram generation process includes receiving, from the hearing aid transceiver assembly, a first surrounding audio information. The
20 audiogram generation process also includes receiving, from the hearing aid transceiver assembly, audiometry test results when an audiometry test is performed on the user. The audiogram generation process also includes generating an audiogram for the user based on the received audiometry test results for the user. The audiogram generation process also includes generating an initial compression ratio for the user based on the generated
25 audiogram for the user. The audiogram generation process also includes generating a predicted compression ratio for the user using an artificial intelligence (AI) training model. The main processor also includes a compression ratio tuner processor. The compression ratio tuner processor is configurable or configured to perform a subsequent test for the user. The subsequent test includes applying the generated predicted compression ratio for the user
30 to a second surrounding audio information. The compression ratio tuner processor is configurable or configured to receive, from the user, subsequent test results for the user based on the subsequent test for the user. The main processor also includes a feedback control processor. The feedback control processor is configurable or configured to generate

an optimized predicted compression ratios for the user based on the subsequent test results. The feedback control processor is also configurable or configured to apply the optimized predicted compression ratio for the user to the hearing aid assembly.

[0007] In yet another exemplary embodiment of the first embodiment, a method for managing a hearing aid assembly is described. The method includes establishing, for the user, a communication channel between a processor and the hearing aid device of the user. The method also includes performing, by the processor via the communication channel, an audiogram generation process. The audiogram generation process includes receiving, by the processor, surrounding audio information. The surrounding audio information including real-time audio-related information of a surrounding environment of the hearing aid assembly. The audiogram generation process also includes performing, by the processor via the hearing aid assembly, an initial audiometry test for the user. The audiogram generation process also includes receiving, by the processor, initial audiometry test results for the user based on the initial audiometry test performed for the user. The audiogram generation process also includes responsive to receiving the surrounding audio information and the initial audiometry test results. The responsive to receiving the surrounding audio information and the initial audiometry test results includes generating, by the processor, an audiogram for the user based on at least the surrounding audio information and the initial audiometry test results. The responsive to receiving the surrounding audio information and the initial audiometry test results also includes generating, by the processor based on the audiogram for the user, an initial compression ratio for the user. The responsive to receiving the surrounding audio information and the initial audiometry test results also includes generating, by the processor based on the initial compression ratio for the user, a predicted compression ratio for the user. The responsive to receiving the surrounding audio information and the initial audiometry test results also includes performing, by the processor, a subsequent test for the user. The subsequent test including applying the generated predicted compression ratio for the user to the surrounding audio information. The responsive to receiving the surrounding audio information and the initial audiometry test results also includes receiving, by the processor from the user, subsequent test results for the user based on the subsequent test performed for the user. The responsive to receiving the surrounding audio information and the initial audiometry test results also includes generating, by the processor, an optimized predicted compression ratio for the user based on subsequent test results. The responsive to receiving the surrounding audio information

and the initial audiometry test results also includes applying, by the processor to the hearing aid assembly, the optimized predicted compression ratio for the user.

- [0008] In an embodiment, a hearing aid system is described. The hearing aid assembly includes a hearing aid transceiver assembly. The hearing aid assembly is configured to be securable to a user. The hearing aid assembly includes a hearing aid transceiver assembly. The hearing aid transceiver assembly is configurable or configured to selectively emit audio signals to the user, the audio signals including pure tone signals. The hearing aid transceiver assembly is configurable or configured to obtain surrounding audio information, the surrounding audio information including real-time surrounding audio-related information.
- 10 The hearing aid assembly also includes a digital signal processor. The digital signal processor configured to perform the surrounding audio adjustment process. The hearing aid assembly also includes a main processor. The main processor is in communication with the hearing aid assembly. The main processor includes an audiometric profile processor. The audiometric profile processor is configurable or configured to perform an audiometric
- 15 profile generation process. The audiometric profile generation process includes sending, to the hearing aid transceiver assembly, a command to perform an audiometry test on the user. The audiometry test including the hearing aid transceiver assembly emitting pure tone signals to the user. The audiometric profile generation process includes receiving, from the hearing aid transceiver assembly, audiometry test results. The audiometry test results
- 20 including a hearing threshold of the user based on the audiometry test performed on the user. The audiometric profile generation process includes generating an audiometric profile for the user based on the received hearing threshold of the user. The audiometric profile generation process includes sending the audiometric profile to a hearing profile processor. The main processor also includes the hearing profile processor. The hearing profile
- 25 processor is configurable or configured to perform a hearing profile generation process. The hearing profile generation process includes receiving, from the audiometric profile processor, the audiometric profile. The hearing profile generation process also includes generating, based on the received audiometric profile, a hearing profile for the user. The hearing profile having at least one hearing parameter for audio processing. The hearing
- 30 profile generation process also includes performing a hearing profile optimization process to generate an optimized hearing profile. The hearing profile generation process also includes instructing the hearing aid assembly to perform the surrounding audio adjustment process based on the optimized hearing profile by sending the optimized hearing profile to

the hearing aid transceiver assembly and instructing the digital signal processor to perform the surrounding audio adjustment process. The surrounding audio adjustment process includes receiving, from the hearing aid transceiver assembly, the surrounding audio information. The surrounding audio adjustment process also includes determining, based on the surrounding audio information, an environment classifier, the environment classifier being a classification of a current surrounding environment of the user determined based on the received surrounding audio information. The surrounding audio adjustment process includes generating an adjusted audio output for the user by adjusting, based on the environment classifier and the optimized hearing profile, one or more audio processing parameters of the surrounding audio information.

[0009] In yet another exemplary embodiment, a method for managing a hearing aid assembly is described. The method includes establishing, for a user, a communication channel between a main processor and the hearing aid device of the user. The method also includes performing, by the processor via the communication channel, an audiometric profile generation process. The audiometric profile generation process includes sending, by the processor, command to perform an audiometry test on the user. The audiometry test includes the hearing aid transceiver assembly emitting pure tone signals to the user. The audiometric profile generation process also includes receiving, from the hearing aid transceiver assembly, audiometry test results. The audiometry test results including a hearing threshold of the user based on the audiometry test performed on the user. The audiometric profile generation process also includes generating an audiometric profile for the user based on the received hearing threshold of the user.

[0010] The audiometric profile generation process also includes sending the audiometric profile to a hearing profile processor. The method also includes performing, by the processor via the communication channel, a hearing profile generation process. The hearing profile generation process including receiving, from the audiometric profile processor, the audiometric profile. The hearing profile generation process also generating a hearing profile for the user, the hearing profile having at least one hearing parameter for audio processing. The hearing profile generation process also includes instructing the hearing aid assembly to perform the surrounding audio adjustment process based on the hearing profile by sending the hearing profile to the hearing aid transceiver assembly and instructing the hearing aid transceiver assembly to perform the surrounding audio adjustment process. The surrounding audio adjustment process includes receiving, from the hearing aid transceiver

assembly, the surrounding audio information. The surrounding audio adjustment process further includes determining, based on the surrounding audio information, an environment classifier, the environment classifier being a classification of a current surrounding environment of the user determined based on the received surrounding audio information.

- 5 The surrounding audio adjustment process also includes generating an adjusted audio output for the user by adjusting, based on the environment classifier and the hearing profile, one or more audio processing parameters of the surrounding audio information.

Brief Description of the Figures

- 10 [0011] For a more complete understanding of the present disclosure, example embodiments, and their advantages, reference is now made to the following description taken in conjunction with the accompanying figures, in which like reference numbers indicate like features, and:

[0012] **Figure 1** is an illustration of an example embodiment of an overall system for managing a hearing aid device of a first embodiment;

- 15 [0013] **Figure 2** is an illustration of an example embodiment of a hearing aid assembly;

[0014] **Figure 3** is an illustration of an example embodiment of a main processor;

[0015] **Figure 4** is an illustration of an example embodiment of a compression ratio tuner processor;

- 20 [0016] **Figure 5** is an illustration of an example embodiment of an overall method for a hearing aid device;

[0017] **Figure 6** is an illustration of an example embodiment of the audiogram generation process;

[0018] **Figure 7** is an illustration of an example embodiment of the method for managing the hearing aid device;

- 25 [0019] **Figure 8** is an illustration of another example embodiment of an overall system for managing a hearing aid device;

[0020] **Figure 9** is an illustration of another example embodiment of a hearing aid assembly;

[0021] **Figure 10** is an illustration of another example embodiment of a main processor;

- 30 [0022] **Figure 11** is an illustration of another example embodiment of an audiometric profile processor;

[0023] **Figure 12** is an illustration of another example embodiment of a hearing profile processor;

[0024] Figure 13 is an illustration of another example embodiment of a digital signal processor; and

[0025] Figure 14 is an illustration of another example embodiment of a method for managing the hearing aid device.

- 5 [0026] Figure 15 is an illustration of an example embodiment of a surrounding audio adjustment process. Although similar reference numbers may be used to refer to similar elements in the figures for convenience, it can be appreciated that each of the various example embodiments may be considered to be distinct variations.

[0027] Example embodiments will now be described with reference to the accompanying
10 figures, which form a part of the present disclosure and which illustrate example embodiments which may be practiced. As used in the present disclosure and the appended claims, the terms "embodiment", "example embodiment", "exemplary embodiment", and "present embodiment" do not necessarily refer to a single embodiment, although they may, and various example embodiments may be readily combined and/or interchanged without
15 departing from the scope or spirit of example embodiments. Furthermore, the terminology as used in the present disclosure and the appended claims is for the purpose of describing example embodiments only and is not intended to be limitations. In this respect, as used in the present disclosure and the appended claims, the term "in" may include "in" and "on", and the terms "a", "an", and "the" may include singular and plural references. Furthermore,
20 as used in the present disclosure and the appended claims, the term "by" may also mean "from", depending on the context. Furthermore, as used in the present disclosure and the appended claims, the term "if" may also mean "when" or "upon", depending on the context. Furthermore, as used in the present disclosure and the appended claims, the words "and/or" may refer to and encompass any and all possible combinations of one or more of the
25 associated listed items.

Detailed Description

[0028] Present example embodiments relate generally to and/or include a system and method for a hearing aid device to achieve an optimum hearing prescription at a desired level based on the current/present surrounding of the user for addressing conventional
30 problems, including those described above and in the present disclosure, and more specifically, example embodiment relate to the system including a hearing device, a user

device, a main processor, and a network for the hearing aid, and those other problems described above and in the present disclosure.

[0029] Example embodiments will now be described below with reference to the accompanying figures, which form a part of the present disclosure.

5 **[0030] Example embodiments of an overall system for a hearing aid system (e.g. system 100).**

[0031] As an overview, an example embodiment of a hearing aid system (e.g., system 100 or hearing aid system 100) is illustrated in **FIGURE 1**. The system 100 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, to manage a hearing aid assembly. Specifically, the system 100 is configurable or configured to improve, support, or enhance bone conduction-based hearing assistance or system, and to provide or improve the performance of bone conduction-based hearing assistance or system through adaptive audiometric tuning. The system 100 may include, communicate with, and/or manage one or more other elements, including one or more one or more user devices (e.g., user devices 10). The system 100 may also include, communicate with, and/or manage one or more databases (e.g., database 30). The system 100 may also include, communicate with, and/or manage one or more one or more hearing aid assemblies (e.g., hearing aid assembly 200). The system 100 may also include, communicate with, and/or manage one or more one or more processors or main processors (e.g., processor 300 or main processor 300). The system 100 is also further configurable or configured to establish communication channels or communicatively linked, via one or more network (e.g., network 20), between one or more user devices 10, one or more database 30, one or more hearing aid assemblies 200, and/or one or more processors or main processors 300.

25 **[0032]** In one embodiment, the hearing aid system 100 includes a hearing aid assembly. The hearing aid assembly 200 is configurable or configured to be securable to a user. The hearing aid assembly 200 includes a hearing aid transceiver assembly 210. The hearing aid transceiver assembly 210 is configurable or configured to selectively emit audio signals to the user based on instructions received from a main processor 300. The hearing aid transceiver assembly 210 is also configurable or configured to obtain surrounding audio information. The surrounding audio information includes real-time surrounding audio-related information of a surrounding environment of the hearing aid assembly.

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[0033] The system also includes one or more main processors. The main processor is configurable or configured to communicate with the hearing aid assembly. The main processor includes an audiometric processor. The audiometric processor is configurable or configured to perform an audiogram generation process. The audiogram generation process includes receiving, from the hearing aid transceiver assembly, the surrounding audio information. The audiogram generation process also includes sending, to the hearing aid transceiver assembly, a command to perform an audiometry test on the user. The audiogram generation process further includes receiving, from the hearing aid transceiver assembly, audiometry test results when the audiometry test is performed on the user. The audiogram generation process further includes generating an audiogram for the user based on the received audiometry test results for the user. Once the audiogram is generated, the audiogram generation process includes generating an initial compression ratio for the user based on the generated audiogram for the user; and generating a predicted compression ratio for the user based on the generated initial compression ratio

[0034] In yet another example embodiment, the system 100 is configurable or configured to generate an audiometric profile based on results and/or hearing thresholds of the user 10. The system 100 is configurable or configured to perform one or more audiometric testing or assessment, where hearing tests or assessments can be performed directly in real-time or real-world through the hearing aid assembly 200 with the main processor 300 and/or one of its elements, which will be further described in the present disclosure. The audiometric testing or assessment may be performed in-situ using the hearing aid assembly 200 and/or an audiometric profile processor 310. The hearing tests or assessments may be performed by emitting selective audio signals to the user, including pure tone signals, which have been calibrated across various frequencies and volumes. The system 100, via the audiometric profile generator 310, may also receive one or more user's responses or feedback to obtain or generate audiometry test results or real-ear measurements (REM) including, but not limited to, hearing threshold measurements, delays in response, hearing side, crossover detection, signal clarity, and others. The audiometric profile processor 310 then processes these one or more measurements or parameters to generate an audiometric profile that represents the user's specific hearing capabilities or capacities. The audiometric profile may include, but not limited to, an audiogram, user response time, crossover detection, hearing side, target hearing side, and/others. The system 100 may also be configurable or configured to perform a crossover management process during the audiometric test or assessment. As

will be described further in the present disclosure, the system 100 is configurable or configured to perform detection of and/or correction to the crossover condition by repositioning the test pure tone signal via based on the user's response and/or feedback which is obtained via a user interface comprising user guided control elements. The system

5 100 is further configurable or configured to update or replace the existing measurements of the audiometric profile to reflect a more accurate audiometry test results.

[0035] In yet another example embodiment, the system 100 is configurable or configured to generate a hearing profile based on the audiometric profile from the audiometric profile processor 310. The hearing profile, as generated by a hearing profile processor 320,

10 includes one or more audio or signal processing parameters which will be utilized to adjust or optimize the auditory perception of the user. The system 100 may also be configurable or configured to receive and/or obtain one or more parameters, including but not limited to, compression ratio, insertion gain including soft gain, moderate gain, or loud gain, or any other audio/signal processing parameters in order to generate the hearing profile for the user.

15 In some embodiments, the system 100 may also receive information including a sound classifier (or environment classifier or acoustic scene classifier) to dynamically adapt the hearing aid assembly 200 to the user's current or real-time environment. The sound classifier may reside within the digital signal processor 220. Alternatively or in addition, the sound classifier may also reside within the main processor 300 and/or one of its elements.

20 Alternatively or in addition, the sound classifier may reside within the parameter optimization processor (e.g., parameter optimization processor 330), which will be further described in the present disclosure. The parameter optimization processor 330 is configurable or configured to analyse or evaluate whether an adjustment to the existing or active hearing profile. Upon classification and evaluation, the system 100 may also be

25 configurable or configured to adapt the existing or active hearing profile to generate a resulting hearing profile. The system 100 and/or the digital signal processor 220 is configurable of configured to adjust, based on the resulting hearing profile and sound classifier, audio processing parameters of the surrounding audio to generate an audio output.

[0036] To perform the actions, functions, processes, and/or methods described above and

30 in the present disclosure, example embodiments of the method include one or more steps.

[0037] For example, as illustrated in **FIGURE 1**, the system 100 may also include and/or communicate with a hearing aid assembly 200. As will be further described in the present disclosure, the hearing aid assembly 200 is configurable or configured to amplify sounds

that are programmed to suit the level of hearing loss. In example embodiments, the hearing aid assembly 200 is also configurable or configured to communicate with, establish a connection with, and/or include a link to (e.g., a communication channel) a user device 10. Alternatively or in addition, the hearing aid assembly 200 is configurable or configured to communicate with, establish a connection with, and/or include a link to a main processor 300 (as described in the present disclosure, in example embodiments, the main processor 300 may be, form part of, include, or the like, the user's mobile device; the main processor 300 may also be or include a central processor, cloud computing, etc.).

[0038] Alternatively or in addition, the system 100 may include and/or communicate with one or more user devices 10 (e.g., via a mobile application of the user mobile device (referred to interchangeably herein as a "user device mobile application", "mobile application", "mobile device", "main processor", or "processor")). Such user device mobile application may include and/or be installed and run/executed on, for example, mobile devices, tablet devices, wearable devices, laptop or other portable computing devices, desktop or other non-portable computing devices, cloud computing devices, and/or the like. Each user device mobile application is configurable or configured to communicate, directly or indirectly, with one or more main processors 300, hearing aid assembly 200, database 30, and/or one or more other elements of the system 100. For example, the user device mobile application is configurable or configured to send or transmit (e.g., via network) user's feedback to the audiometry test.

[0039] Alternatively or in addition, the system 100 may include one or more main processors 300. As will be further described in the present disclosure, each main processor 300 is configurable or configured to manage and/or control one or more hearing aid assemblies 200. In example embodiments, each main processor 300 may also be configurable or configured to manage and/or control one or more user device 10. Each main processor 300 is configurable or configured to manage, connect and/or communicate directly or indirectly one or more databases 30 (e.g., central databases, distributed or non-centralized databases, cloud computing, blockchain, etc.). Each main processor 300 may also be configurable or configured to receive the surrounding audio information and the audiometry test results for the user from the hearing aid assembly 200. Each main processor 300 may also be configurable or configured to perform one or more aspects of an audiometric profile generation process, as described in the present disclosure, including receiving audiometry test results from the hearing aid transceiver assembly which includes

one or more hearing thresholds. Each main processor 300 may also be configurable or configured to generate the audiometric profile of the user based on the received hearing thresholds of the user. Each main processor 300 may also be configurable or configured to generate one or more audiograms for the user based on the received audiometry test results.

5 Each main processor 300 may also be configurable or configured to generate one or more prescriptive insertion gains for the user. Each main processor 300 may also be configurable or configured to generate one or more initial compression ratios for the user. Each main processor 300 may also be configurable or configured to generate one or more predicted compression ratios. Each main processor 300 may also be configurable or configured to

10 perform one or more aspects of a compression ratio tuning process. Each main processor 300 may also be configurable or configured to apply the generated predicted compression ratios for the user to the surrounding audio information to arrive at one or more compressed surrounding audio. Each main processor 300 may also be configurable or configured to receive feedback from the user on the one or more compressed surrounding audio. Each

15 main processor 300 may also be configurable or configured to assess the feedback from the user on the one or more compressed surrounding audio to arrive at one or more feedback data. Each main processor 300 may also be configurable or configured to perform an AI model training using the compressed surrounding audio and the feedback data to arrive at a trained AI model. Each main processor 300 may also be configurable or configured to

20 responsive to receiving a real-time surrounding environmental audio.

[0040] The system 100 may also include and/or communicate with one or more networks, communication channels, or the like. Each network is configurable or configured to enable communications between one or more elements of the system 100. For example, the network may be configurable or configured to enable one or more hearing aid devices 100

25 to send the audiometry test results to a main processor 300. As another example, the network may be configurable or configured to enable the main processor 300 to perform the compression ratio tuning based on AI model. In yet another example, the network may be configurable or configured to enable one or more user device mobile application to communicate with one or more database 20. In yet another example, the network may be

30 configurable or configured to enable one or more hearing aid device 100 to perform the audiometry test. communicate with one or more database 20. In yet another example, the network may be configurable or configured to enable one or more hearing aid device 100 to communicate with one or more database.

[0041] It is to be understood in the present disclosure that, although the functions and/or processes performed by the system are described in the present disclosure as being performed by particular element(s) of the system, the functions and/or processes performed by a particular element of the system 100 may also be performed by one or more other elements and/or cooperatively performed by more than one element of the system 100 without departing from the teachings of the present disclosure. It is also to be understood in the present disclosure that, although the functions and/or processes performed by the system 100 are described in the present disclosure as being performed by particular elements of the system 100, the functions and/or processes performed by two or more particular elements of the system 100 may be combined and performed by one element of the system 100 without departing from the teachings of the present disclosure.

[0042] As used in the present disclosure, when applicable, a reference to a system (e.g., system 100), processor (e.g., main processor 300), elements of a system 100 and/or main processor 300, or the like, may also refer to, apply to, and/or include a computing device, processor, server, system, cloud-based computing, or the like, and/or functionality of a processor, computing device, server, system, cloud-based computing, or the like. The system 100 and/or main processor 300 (and/or its elements, as described in the present disclosure) may be any processor, server, system, device, computing device, controller, microprocessor, microcontroller, microchip, semiconductor device, or the like, configurable or configured to perform, among other things, a processing and/or managing of information, data communications, user requests, hashing of information, encryption and decryption of information, creating digital signatures, and/or any other actions described above and in the present disclosure. Alternatively or in addition, the system 100 and/or main processor 300 (and/or its elements, as described in the present disclosure) may include and/or be a part of a virtual machine, software, processor, computer, node, instance, host, or machine, including those in a networked computing environment. As used in the present disclosure, a network 30 and/or cloud may be a collection of devices connected by communication channels that facilitate communications between devices and allow for devices to share resources. Such resources may encompass any types of resources for running instances including hardware (such as servers, clients, mainframe computers, networks, network storage, data sources, memory, central processing unit time, scientific instruments, and other computing devices), as well as software, software licenses, available network services, and other non-hardware resources, or a combination thereof. A network 30, communication

channel 30, cloud 30, or the like, may include, but is not limited to, computing grid systems, peer to peer systems, mesh-type systems, distributed computing environments, cloud computing environment, etc. Such network 30, communication channel 30, cloud 30, or the like, may include hardware and software infrastructures configured to form a virtual organization comprised of multiple resources which may be in geographically disperse locations. Network 30 may also refer to a communication medium between processes on the same device. Also as referred to herein, a network element, node, or server may be a device deployed to execute a program operating as a socket listener and may include software instances.

10 [0043] In an example embodiment, the system 100 includes the following components.

[0044] The user device (e.g., the user device 10).

[0045] An example embodiment of the hearing aid system 100 includes one or more user device 10. The user device 10 may be in communication, via network 30, with the database 30, the hearing aid assembly 200 and the main processor 300. As described, a user device 15 10 may be user devices of users 10 (e.g., user 10, or patients 10). The user device 10 may be or include, mobile device 10, tablet device 10, wearable device 10, laptop or other portable computing device 10, desktop or other non-portable computing device 10, workstation 10, networked computing device 10, virtual computing device 10, virtual instances of a computing device 10, cloud computing device 10, and/or the like.

20 [0046] As described in the first embodiment, the user device 10 is configurable or configured to communicate with one or more databases 20. The database 20 may also store, but not limited to, information such as user data. The user device 10 may receive (or retrieve) such user data including, but is not limited to, personal data of a user (e.g., name, age, gender, identity, health condition, hearing condition, medical officers in charge, etc.), health 25 information (e.g., hearing condition, medical records, etc.), historical information (e.g., historical medical information, historical medical records, historical medical tests, historical hearing tests, historical hearing tests results, etc.), and/or surrounding audio information.

[0047] Such information received by the user device 10 may be received or retrieved when the main processor 300 receives a command and/or request to initiate or establish a 30 communication channel between the user device 10, the hearing aid assembly 200 and the main processor 300. The information received by the user device 10 may be received in real-time and/or near real-time. Alternatively or in addition, the information may also be received when there are changes, edits, deletions, additions, updates, etc. to the one or more

information of the users 10. The user device 10 may also be configurable or configured to communicate with the database 30 to update and/or store the one or more information that have gone through changes, edits, deletions, additions, updates, etc.

[0048] The database (e.g., database 20).

5 **[0049]** As illustrated in at least **FIGURE 1**, an example embodiment of a system 100 includes one or more databases (e.g., database 20). The database 30 is configurable or configured to perform a plurality of actions, functions, operations, methods, and/or processes, including managing the hearing aid assembly 200. The database 20 may also be configurable or configured to access, manage, store, receive, edit, change, delete, update,
10 and/or otherwise utilize various information to be used by the system 100 for managing the hearing aid assembly 200.

[0050] The system 100 may also include and/or communicate with one or more networks, communication channels, or the like (e.g., communication channels 30), which are used to enable communication between elements of the system 100. The system 100 may also
15 include and/or communicate with one or more databases, distributed ledgers, or the like (e.g., database 20) to store, search, and/or retrieve information. For example, the database may manage or store information pertaining to audio or frequency of the surrounding environment and/or other hearing parameters which may affect the user hearing capabilities.

[0051] In an example embodiment, the database 20 may include, but not limited to,
20 information pertaining to surrounding environment, surrounding audio, parameters (e.g., geolocation, date/time, temperature, pressure, humidity, user's hearing condition (e.g., sensorineural, single-side deafness, conductive, mixed, etc.), audiometry test results (e.g., ability to hear, degree or type of hearing loss, hearing scores for each ear, etc.), hearing profile (e.g., hearing parameters, initial compression ratio, personalized hearing profile,
25 etc.), user information, user feedbacks or responses (e.g., spatial axis rating, UI feedback, preference ranking, text input, etc.), and/or user preferences. These information are obtained from the user device 10, the hearing aid assembly 200, and/or the main processor 300.

[0052] The database 20 may be configurable or configured to store, but not limited to,
30 information such as user data. The user data may include, but is not limited to, personal data of a user (e.g., name, age, gender, identity, health condition, hearing condition, medical officers in charge, etc.), health information (e.g., hearing condition, medical records, etc.), historical information (e.g., historical medical information, historical medical records,

historical medical tests, historical hearing tests, historical hearing tests results, etc.), and/or surrounding audio information.

[0053] In yet another example, the database 20 may be configurable or configured to manage or store the audiometry test results from the pure tone audiometry test which determines higher and lower boundaries for which true value of hearing threshold of the user lies. The database 20 may also be configurable or configured to manage or store information pertaining to amount of volume the user may need to add to each frequency band to compensate for hearing loss. The database 20 may be configurable or configured to store such information for further utilize in predicting user's preferences.

10 [0054] Although Figure 1 may illustrate one database 20, it is to be understood that the system 100 may include more or less than one database 20 without departing from the teachings of the present disclosure.

[0055] **The network (e.g., network 30).**

[0056] As used in the present disclosure, a network 30 and/or cloud 30 may be a collection of devices connected by communication channels that facilitate communications between the elements of the system 100 and allow for the elements of the system 100 to share resources. Such resources may encompass any types of resources for running instances including hardware (such as servers, clients, mainframe computers, networks, network storage, data sources, memory, central processing unit time, scientific instruments, and other computing devices), as well as software, software licenses, available network services, and other non-hardware resources, or a combination thereof. A network 30 or cloud may include, but is not limited to, computing grid systems, peer to peer systems, distributed computing environments, cloud computing environment, etc. Such network 40 or cloud may include hardware and software infrastructures configured to form a virtual organization comprised of multiple resources which may be in geographically disperse locations. Network 40 may also refer to a communication medium between processes on the same device.

[0057] **The hearing aid assembly (e.g., hearing aid assembly 200).**

[0001] FIGURE 2 illustrates an example embodiment of the hearing aid system 100. The hearing aid system 100 includes one or more hearing aid assemblies (e.g., hearing aid assembly 200). Each hearing aid assembly 200 is configurable or configured to emit sound to the user's. To do so, each hearing aid assembly 200 is configurable or configured to communicate with one or more elements of the system 100, including one or more elements of user device 10, database 20, network 30, main processor 300, communication channels

(not shown), information sources (not shown), etc. For example, the hearing aid assembly 200 may be in communication with the main processor 300 (e.g., to selectively emit audio signals to the user based on instructions received from the main processor 300).

[0058] As will be further described in the present disclosure, the hearing aid assembly 200 includes a hearing aid transceiver assembly 210. The hearing aid transceiver assembly 210 is configurable or configured to emit surrounding environmental sounds and frequency output for each ear of the user. The hearing aid assembly 210 also includes at least one sound capturing element (e.g., microphone or sensor) for receiving sound from the surrounding environment. The at least one sound capturing element is configurable or configured to capture ambient sound. The sound capturing element is also configurable or configured to receive sound from the surrounding environment.

[0059] Alternatively, the hearing aid assembly 200 includes a main body (housing part) for each ear. The main body may (or may not) include a power/mode button, status indication for the device (e.g., an LED, or the like), volume buttons, and/or a battery charging port. In operation, the main body is configurable or configured to be worn in any known way (e.g. when the hearing aid assembly is a bone conduction hearing aid, the main body is configurable or configured to be worn behind the ear). The hearing aid assembly 200 also includes at least one sound capturing element (not shown), such as microphone and/or sensor, to capture ambient sounds, real-time surrounding audio-related information, information pertaining to date, time, pressure, humidity, geolocation, pressure, etc. The hearing aid assembly 200 may include an amplifier (not shown) to increase the sound level for better hearing. The hearing aid assembly 200 may also include a speaker (not shown) to deliver the amplified sound to the user's ears. The hearing assembly 200 may also include a power source (not shown) to recharge battery that powers the hearing aid system 100.

[0060] In an example embodiment, the hearing aid assembly 200 may also be configurable or configured to communicate and/or cooperate with artificial intelligence (AI), machine learning, and/or deep learning algorithms, including Region Based Convolutional Neural Networks (R-CNN), You Only Look Once (YOLO) and/or any other algorithms which may be used.

[0061] In an example embodiment, the hearing aid assembly 200 includes a main input interface 201, hearing aid transceiver assembly 210, and a main output interface 220, as will be further described in the present disclosure.

[0062] **The main input interface (e.g., main input interface 201).**

[0063] As illustrated in at least **FIGURE 2**, the hearing aid assembly 200 includes one or more main input interfaces (e.g., main input interface 201). Each main input interface 201 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 100. The main input interface 201 is also configurable or configured to communicate with one or more elements of the system 100, including one or more hearing aid transceiver assembly 210, one or more databases 30, one or more networks 40, one or more main processor 300 and/or one or more communication channels (not shown). Furthermore, the main input interface 201 is configurable or configured to receive, request, retrieve, and/or obtain information from one or more information sources (e.g., databases and networks) and/or resources (e.g., tools and/or applications).

[0064] In an example embodiment, the main input interface 201 may be configurable or configured to receive, retrieve, request, obtain, select, filter, and/or route information pertaining to real-time surrounding audio-related information of a surrounding environment of the hearing aid assembly 200. The surrounding audio-related information may be received, by the main input interface 201, from one or more elements of the hearing aid system 100. As described in the present disclosure, surrounding audio-related information may include, but is not limited to, at least one of the following information: date, time, pressure, humidity, geolocation, pressure, etc.. The surrounding audio-related information may include any kind of data and/or content that is in an audio signal, including sounds like music, communication, speech, or other audio recordings. The surrounding audio information may be received from, for examples, but not limited to, Global Positioning System (GPS) on iOS or Android operating system, etc. As described in the present disclosure, the main input interface 201 is configurable or configured to communicate with one or more databases 30. The main input interface 201 may also receive, retrieve, request, obtain, select, filter, and/or route information from the database 30. The information from the database 30 may include information pertaining to surrounding environment, surrounding audio, parameters (e.g., geolocation, date/time, temperature, pressure, humidity, user's hearing condition (e.g., sensorineural, single-side deafness, conductive, mixed, etc.), audiometry test results (e.g., ability to hear, degree or type of hearing loss, hearing scores for each ear, etc.), hearing profile (e.g., hearing parameters, initial compression ratio, personalized hearing profile, etc.), user information, user feedbacks or

responses (e.g., spatial axis rating, UI feedback, preference ranking, text input, etc.), and/or user preferences.

[0065] The main input interface 201 is also configurable or configured to communicate with one or more hearing aid transceiver assembly 210, as will be further described in the present disclosure.

[0066] The hearing aid transceiver assembly (e.g., hearing aid transceiver assembly 210).

[0067] As illustrated in at least **FIGURE 2**, the hearing aid assembly 200 includes one or more hearing aid transceiver assembly (e.g., hearing aid transceiver assembly 210). The hearing aid transceiver assembly 210 is configurable or configured to communicate with one or more elements of the system 100, including one or more elements of user device 10, database 30, network 40, main processor 300, communication channels (not shown), information sources (not shown), etc.

[0068] In an example embodiment, the hearing aid transceiver assembly 210 is configurable or configured to selectively emit audio signals to the user based on instructions received from a main processor 200. The hearing aid transceiver assembly 210 is also configurable or configured to be integrated into the hearing aid assembly 200 to perform the following functions, for example, communicating via wireless communication with external devices such as smartphones, computers, software, and other hearing aids. This allows for streaming audio, remote control, wireless communication, AI-based computing, Bluetooth, cloud-based computing, and data synchronization within the hearing aid system 100. The hearing aid transceiver assembly 210 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 100. The hearing aid transceiver assembly 210 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, orchestrating communication, transfers, exchanges, or the like, of information between elements of the main processor 300 and/or between one or more elements of the main processor 300 and one or more elements of the main processor 300 and/or system 100.

[0069] As an example, the hearing aid transceiver assembly 210 is configurable or configured to selectively emit audio signals to the user based on instructions received from a main processor 300. The hearing aid transceiver assembly 210 is configurable or

configured to obtain surrounding audio information, the surrounding audio information including real-time surrounding audio-related information of a surrounding environment of the hearing aid assembly 210. The surrounding audio information may be received from, for examples, but not limited to, Global Positioning System (GPS) on iOS or Android
5 operating system, or a sound capturing element such as a microphone and/or sensor installed in the hearing aid assembly 200. The hearing aid transceiver assembly 210 may include signal processing to enhance sound quality by filtering noise and adjusting frequencies based on the user's hearing profile. The hearing aid transceiver assembly 210 may include a user interface. The user interface allows users to adjust settings such as volume, sound
10 modes, and connectivity options through a companion application or direct controls on the device.

[0070] The hearing aid assembly may also be configurable or configured to communicate and/or cooperate with artificial intelligence (AI), machine learning, and/or deep learning algorithms, including Region Based Convolutional Neural Networks (R-CNN), You Only
15 Look Once (YOLO) and/or any other algorithms which may be used.

[0071] The hearing aid transceiver assembly 210 is also configurable or configured to communicate with one or more elements of the system 100, including one or more user devices 10, one or more hearing aid assemblies 200, one or more databases 30, one or more networks 40, and one or more main processors 300. The hearing aid transceiver assembly
20 210 is configurable or configured to receive, request, retrieve, and/or obtain instruction and/or information from one or more information sources (e.g., user information) and/or resources (e.g., tools and/or applications). The one or more information sources and/or resources may be related to or include, but are not limited to, users 10, user devices 10, databases 30, networks 40, communication channels 40, other elements of the main
25 processor 300, etc.

[0072] In an example embodiment, the hearing aid transceiver assembly 210 is configurable or configured to selectively emit audio signals to the user based on instructions received from a main processor. The hearing aid transceiver assembly 210 is configurable or configured to obtain surrounding audio information, the surrounding audio information
30 including real-time surrounding audio-related information of a surrounding environment of the hearing aid assembly.

[0073] The hearing aid transceiver assembly 210 is also configurable or configured to communicate with one or more main output interface 220, one or more main processor 300, and/or other elements of system 100 as will be further described in the present disclosure.

[0074] The main output interface (e.g., main output interface 220)

5 [0075] The hearing aid assembly 200 includes one or more main output interfaces (e.g., main output interface 220) (not shown). The main output interfaces is configurable or configure to send information relating to audio signal and/or surrounding audio to the user. Each main output interface 220 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not
10 limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 100. The main output interface 220 is also configurable or configured to communicate with one or more elements of the system 100, including one or more hearing aid transceiver assembly 210, one or more databases 30, one or more networks 40, one or more main processor 300 and/or one or more communication channels (not
15 shown). Furthermore, the main output interface 220 is configurable or configured to receive, request, retrieve, and/or obtain information from one or more information sources (e.g., databases and networks) and/or resources (e.g., tools and/or applications)

[0076] The main processor (e.g., main processor 300).

[0077] As illustrated in at least FIGURE 3, in the first embodiment, the system 100 for
20 managing one or more hearing aid system (e.g., hearing aid system 100) includes one or more main processors (e.g., main processor 300). The main processor 300 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, managing a hearing aid system 100, receiving one or more information or details from the user device 10, and/or managing a
25 hearing aid assembly 200.

[0078] As a non-limiting example, each main processor 300 may include one or more elements configurable or configured to perform a variety of actions, functions, operations, methods, and/or processes, including, but not limited to, managing hearing device system 100. More specifically, the main processor 300 is configurable or configured to manage,
30 monitor and/or control the operations of a hearing aid assembly 200.

[0079] The main processor 300 is also configurable or configured to manage, store, and/or retrieve various information from the database 30 to be used by the system 100 to manage a hearing aid assembly 200 of one or more user devices 10. The main processor 300 is

configurable or configured to communicate with the one or more user information databases 30 to access, manage, store, receive, edit/change/delete, update, and/or otherwise utilize information to be used by the system 100 to manage a hearing aid assembly 200 of one or more user devices 10. As described in the present disclosure, the database 30 may include
5 information such as, but not limited to, user data, patient data, medical records, medical tests, hearing tests, hearing condition, surrounding audio information, etc.

[0080] The main processor 300 is configurable or configured to establish one or more communication channels with the hearing aid assembly (e.g., hearing aid assembly 200). The main processor 300 includes the audiometric processor 320. The audiometric processor
10 320 is configurable or configured to perform an audiogram generation process. The main processor 300 is also configurable or configured to establishing, for the user, a communication channel between the main processor 300 and the hearing aid device 200 of the user; performing, by the main processor 300 via the communication channel, an audiogram generation process, the audiogram generation process including: receiving, by
15 the main processor 300, pure tone signals at each frequency; performing, by the main processor 300 via the hearing aid assembly 200, an initial audiometry test for the user; receiving, by the main processor 300, initial audiometry test results for the user based on the initial audiometry test performed for the user; responsive to receiving the initial audiometry test results: generating, by the main processor 300, an audiogram for the user
20 based on at least the initial audiometry test results; generating, by the main processor 300 based on the audiogram for the user, an initial compression ratio for the user; generating, by the main processor 300 based on the initial compression ratio for the user, a predicted compression ratio for the user; performing, by the main processor 300, a subsequent test for the user, the subsequent test including receiving by the main processor 300, surrounding
25 audio information, the surrounding audio information including real-time audio-related information of a surrounding environment of the hearing aid assembly 200, applying the generated predicted compression ratio for the user to the surrounding audio information; receiving, by the main processor 300 from the user, subsequent test results for the user based on the subsequent test performed for the user; generating, by the main processor 300, an
30 optimized predicted compression ratio for the user based on subsequent test results; and applying, by the processor to the hearing aid assembly 200, the optimized predicted compression ratio for the user.

[0081] Alternatively or in addition, the main processor 300 is also configurable or configured to continuously receives the surrounding audio information in real-time. The surrounding audio information may include, but not limited to, a first surrounding audio obtained at a first time when the main processor 300 performs the audiometry test based on
5 the first surrounding audio, a second surrounding audio obtained at a second time after the first time when the main processor 300 performs the subsequent tests based on the second surrounding audio, and/or the main processor performs the subsequent test based on the first and second surrounding audio information.

[0082] Alternatively or in addition, the main processor may also be configurable or
10 configured to receive, collect, and/or store information, including sound-related information (e.g., surrounding, existing, historical, average/mean/etc., sound at a geolocation, location, address, landmark, area, region, etc.). The processor may also be configurable or configured to receive, collect, and/or store other information, including historic information pertaining to adjustments proposed, suggested, and/or made by the processor and/or user. The
15 processor may also be configurable or configured to perform predicting, suggesting, determining, and/or adjusting of the hearing aid assembly to achieve improved hearing, including configuring the hearing aid assembly to transmit one or more optimum frequencies for the user based on, among other things, sound-related information received by the processor (e.g., surrounding, existing, historical, average/mean/etc., sound at a
20 geolocation, location, address, landmark, area, region, etc.).

[0083] Alternatively or in addition, the main processor may be configurable or configured to perform one or more of the above actions/functions and/or one or more other actions/functions described in the present disclosure via one or more processors (e.g., a user's mobile device, a central processor, cloud computing, etc.) and/or via calculations,
25 estimations, results, inferences, predictions, or the like, generated and/or derived, directly or indirectly, partially, in cooperation or in whole, by artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes. Such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be part of the processor (also referred to herein as a main processor) and may include, but are not limited to, machine learning
30 algorithms, deep learning algorithms, deep neural networks (DNN), recurrent neural networks (RNN), long short term memory (LSTM), convolutional neural networks (CNN), regional convolutional neural networks (R-CNN), etc. Furthermore, such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be

provided locally via the processor (or main processor) and/or one or more other elements of the system (e.g., within the hearing aid assembly); and/or via one or more communication networks, cloud computing, distributed computing, and/or non-localized or decentralized artificial intelligence (AI), etc.

5 **[0084] The input interface (e.g., the input interface 310)**

[0085] As illustrated in at least **FIGURE 3**, the main processor 300 includes one or more input interfaces (e.g., input interface 310). The input interfaces is configurable or configure to receive information relating to audio signal and/or surrounding audio and send to the audiometric processor 320. Each input interface 310 is configurable or configured to
10 perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 100. The input interface 310 is also configurable or configured to communicate with one or more elements of the system 100, including one or more main output interface 220, one or more databases 30, one or
15 more networks 40, one or more main processor 300 and/or one or more communication channels (not shown). Furthermore, the input interface 310 is configurable or configured to receive, request, retrieve, and/or obtain information from one or more information sources (e.g., databases and networks) and/or resources (e.g., tools and/or applications).

[0086] The audiometric processor (e.g., the audiometric processor 320).

20 **[0087]** In the first embodiment, as illustrated in at least **FIGURE 3**, an example embodiment of the main processor 300 includes one or more audiometric processors (e.g., audiometric processors 320). The audiometric processor 320 is configurable or configured to perform an audiogram generation process. When generating the audiogram, the audiometric processor 320 in communication with the hearing aid assembly 200, is configurable or
25 configured to receive pure tone signals at each frequency. The hearing aid transceiver assembly is configurable or configured to emit audio signals to the user based on instructions received from the main processor 300. The audio signals may include, but not limited to, a stimulus, a pure tone signal. The audiometric processor 320 may be configurable or configured to perform audiometry tests by emitting a stimulus having a
30 frequency from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches, receiving an indication, from the user 10, on whether the user 10 is able to hear the stimulus in each frequency; and analyzing a hearing condition of the user for each frequency based on the results of the audiometry test. The audiometry test, when performed by the

audiometric processor 300 (or the main processor 200) includes 2-20 batches, in each batch including an increase for a period of 10-500 milliseconds followed by a period of 10-500 milliseconds of silence. In another example, the audiometric processor 320 may be in communication with the hearing aid transceiver assembly 210 such that the audiometric processor 320 may instruct the hearing aid transceiver assembly 210 to emit audio signals for performing the audiometry tests.

[0088] The audiometric processor 320 is further configurable or configured to receive one or more audiometry test results when an audiometry test is performed on the user. Based on the audiometry results, the audiometric processor 320 is configurable or configured to generate an audiogram for the user based on the received audiometry test results for the user. The audiogram generation process, as performed by the audiometric processor 320 or the main processor 300, also further includes generating one or more initial compression ratios for the user based on the generated audiogram for the user. This also further includes generating one or more predicted compression ratios for the user using an artificial intelligence (AI) training model.

[0089] Alternatively or in addition, the audiometric processor 320 may also be configurable or configured to generate an insertion gain for the user based on the generated audiogram for the user. The insertion gain. The insertion gain may be sent to the compression ratio tuner processor 350. The insertion gain may or may not be used when generating the predicted compression ratio for the user.

[0090] **The compression ratio tuner processor (e.g., compression ratio tuner processor 350).**

[0091] As illustrated in at least **FIGURE 3**, an example embodiment of the main processor 300 includes one or more compression ratio tuner processors (e.g., compression ratio tuner processor 350). The compression ratio tuner processor 350 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, configuring one or more elements of the system 100. The compression ratio tuner processor 350 is configurable or configured to perform one or more subsequent tests for the user. The subsequent test, as performed by the compression ratio tuner processor 350 and/or the main processor 300 includes receiving the surrounding audio information and applying the generated predicted compression ratio for the user to the surrounding audio information. The compression ratio tuner processor 350 is also configurable or configured to receive subsequent test results for the user based on the

subsequent test for the user. Furthermore, the example embodiment as used in the present disclosure is for the purpose of describing example embodiments only and is not intended to be limitations.

[0092] The compression ratio tuner processor 350 is further configurable or configured to perform one or more additional subsequent tests for the user after performing the subsequent test (e.g., first subsequent test) for the user. This includes performing a second subsequent test for the user and receive second subsequent test results based on the second subsequent test performed for the user. When performing the second subsequent test for the user, the compression ratio tuner processor 350 is configurable or configured to apply the optimized predicted compression ratio for the user to the surrounding audio information. Based on the second subsequent test results, a second optimized predicted compression ratio is generated for the user. The compression ratio tuner processor 350 is further configurable or configured to apply the second optimized predicted compression ratio for the user.

[0093] The compression ratio tuner processor 350 is also configurable of configured to convert/compress the surrounding audio information, as received in real-time or non-real-time, into compressed surrounding audio information. This includes receiving the surrounding audio information as captured by the hearing aid assembly 200, analyzing the surrounding audio information, the analysis including determining one or more characteristics of the surrounding audio information; analyzing the surrounding audio information, the analysis including determining a compression threshold based on the one or more characteristics of the surrounding audio information, the compression threshold being an input sound level at which the compression ratio tuner processor 350 starts to adjust a sound gain; receiving one or more predicted compression ratios from the audiometric processor 320 based on the determined characteristics of the surrounding audio information; comparing the compression threshold of the surrounding audio information with the predetermined threshold of compression for the predicted compression ratios; and responsive to a determination that the compression threshold of the surrounding audio information is within the predetermined threshold of compression for the predicted compression ratio; applying the one or more predicted compression ratios to the surrounding audio information to arrive at one or more compressed surrounding audio information.

[0094] In an example embodiment, the compression ratio tuner processor 350 may include one or more predicted compression ratio input interface 351 (e.g., predicted compression ratio input interface 351), one or more surrounding audio generator 352 (e.g., surrounding

audio generator 352), one or more textual input assessor 362 (e.g., textual input assessor 362), one or more spatial axis rating assessor 364 (e.g., spatial axis rating assessor 364), one or more preferred audio rating assessor 366 (e.g., preferred audio rating assessor 366), and one or more updated output 368 (e.g., updated output 368), as described in the present disclosure.

[0095] The predicted compression ratio input interface (e.g., predicted compression ratio input interface 351).

[0096] As illustrated in at least **FIGURE 4**, an example embodiment of the compression ratio tuner processor 350 includes one or more predicted compression ratio input interface 351. The predicted compression ratio input interface 351 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from the audiometry 320 and/or one or more elements of the system 100. The predicted compression ratio input interface 351 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, orchestrating communication, transfers, exchanges, or the like, of information between elements of the audiometric processor 320 and/or between one or more elements of the main processor 300 and one or more elements of the main processor 300 and/or system 100.

[0097] In an example embodiment, the predicted compression ratio input interface 351 is configurable or configured to receive the predicted compression ratio from the audiometric processor 320. The predicted compression ratio input interface 351 is also configurable or configured to send the predicted compression ratio to the surrounding audio generator 352 for further processing.

[0098] The surrounding audio generator (e.g., surrounding audio generator 352).

[0099] As illustrated in at least **FIGURE 4**, an example embodiment of the compression ratio tuner processor 350 includes one or more surrounding audio generator 352.

[00100] In an example embodiment, each surrounding audio generator 352 is configured or configured to receive the predicted compression ratio from the audiometric processor 320 via predicted compression ratio input interface 351. The surrounding audio generator 352 may be configured or configured to receive the insertion gain from the audiometric processor 320 via predicted compression ratio input interface 351. The surrounding audio generator 352 is also configured or configured to perform the subsequent

test for the user by applying the generated predicted compression ratio for the user to the surrounding audio information. The surrounding audio generator 352 is also configured or configured to send the generated predicted compression ratio applied to the surrounding audio information to textual input assessor 362, spatial axis rating assessor 364, and preferred audio rating assessor 366. The surrounding audio generator 352 is also configured or configured to communicate and/or connect with main processor 300, user, hearing aid assembly 200, database 30, network 40, audiometric processor 320, other surrounding audio generator 352, textual input assessor 362, spatial axis rating assessor 364, and preferred audio rating assessor 366.

10 **[00101] The textual input assessor (e.g., textual input assessor 362).**

[00102] As illustrated in at least **FIGURE 4**, an example embodiment of the compression ratio tuner processor 350 includes one or more textual input assessors 362.

[00103] In an example embodiment, each textual input assessor 362 is configured or configured to receive the generated predicted compression ratio applied to the surrounding audio information from the surrounding audio generator 352. The textual input assessor 362 is also configured or configured to perform the subsequent test by using the textual input feedback. The textual input assessor 362 is also configured or configured to send the subsequent test result via the updated output 368 for the user. The textual input assessor 362 is also configured or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40, audiometric processor 320, surrounding audio generator 352, other textual input assessor 362, spatial axis rating assessor 364, and preferred audio rating assessor 366.

[00104] The spatial axis rating assessor (e.g., spatial axis rating assessor 364).

[00105] As illustrated in at least **FIGURE 4**, an example embodiment of the compression ratio tuner processor 350 includes one or more spatial axis rating assessor 364.

[00106] In an example embodiment, each spatial axis rating assessor 364 is configurable or configured to receive the generated predicted compression ratio applied to the surrounding audio information from surrounding audio generator 352. The spatial axis rating assessor 364 is also configurable or configured to perform the subsequent test by using spatial axis rating feedback. The spatial axis rating assessor 364 is also configured or configured to send the subsequent test result via the updated output 368 for the user. The spatial axis rating assessor 364 is also configurable or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30,

network 40, audiometric processor 320, surrounding audio generator 352, textual input assessor 362, other spatial axis rating assessor 364, and preferred audio rating assessor 366.

[00107] The preferred audio rating assessor (e.g., preferred audio rating assessor 366).

5 **[00108]** As illustrated in at least **FIGURE 4**, an example embodiment of the compression ratio tuner processor 350 includes one or more preferred audio rating assessor 366.

[00109] In an example embodiment, each preferred audio rating assessor 366 is configurable or configured to receive the generated predicted compression ratio applied to the surrounding audio information from surrounding audio generator 352. The preferred audio rating assessor 366 is also configurable or configured to perform the subsequent test by selecting the preferred audio generated by applying the predicted compression ratio to local surrounding audio. The preferred audio rating assessor 366 is also configurable or configured to send the subsequent test result via the updated output 368 for the user device

10 10. The preferred audio rating assessor 366 is also configurable or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40, audiometric processor 320, surrounding audio generator 352, textual input assessor 362, spatial axis rating assessor 364, and other preferred audio rating assessor 366.

20 **[00110] The updated output (e.g., updated output 368).**

[00111] As illustrated in at least **FIGURE 4**, an example embodiment of the compression ratio tuner processor 350 includes one or more updated output 368. The updated output 368 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to,

25 orchestrating communication, transfers, exchanges, or the like, of information between elements of the main processor 300 and/or between one or more elements of the main processor 300 and one or more elements of the main processor 300 and/or system 100. The updated output 368 is also configurable or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40,

30 audiometric processor 320, surrounding audio generator 352, textual input assessor 362, spatial axis rating assessor 364, and other preferred audio rating assessor 366.

[00112] The one or more compression ratio tuner processor 350 is configurable or configured to communicate with the one or more audiometric processor 320 and/or the one or more feedback control processor 370, as described in the present disclosure.

[00113] The feedback control processors (e.g., feedback control processors 370).

5 [00114] As illustrated in at least **FIGURE 3**, an example embodiment of the main processor 300 includes one or more feedback control processors (e.g., feedback control processors 370). The feedback control processor 370 is configurable or configured to generate an optimized predicted compression ratios for the user based on the subsequent test results and to apply the optimized predicted compression ratio for the user to the hearing aid assembly. The feedback control processor 370 is also configurable or configured to continuously receive the feedback data on one or more compressed surrounding audio information to perform an artificial intelligence (AI) model training to arrive at a trained AI model for generating the optimized predicted compression ratios for one or more corresponding surrounding audio information. In addition, the feedback control processor 15 370 is further configurable or configured to generate a predicted real-time compression ratio, including performing an AI model training using the compressed surrounding audio information and the feedback data to arrive at a trained AI model; and responsive to receiving a real-time surrounding environmental audio; applying the real-time surrounding environmental audio to the trained AI model to generate real-time compression ratios; and 20 applying the generated real-time compression ratios to the hearing aid assembly.

[00115] Although the figures may illustrate one main hearing aid transceiver assembly 210, one audiometric processor 320, one compression ratio tuner processor 350, and one feedback control processor 370, and one main output interface 220, it is to be understood that the main processor 300 may include more or less than one hearing aid 25 transceiver assembly 210, more or less than one audiometric processor 320, more or less than one compression ratio tuner processor 350, more or less than one feedback control processor 370, and/or more or less than one main output interface 220 without departing from the teachings of the present disclosure. It is also to be understood in the present disclosure that, although the actions, functions, processes, and/or methods performed by the 30 main processor 300 may be described in the present disclosure as being performed by one or more particular elements of the main processor 300, the actions, functions, processes, and/or methods performed by a particular element of the main processor 300 may also be performed by one or more other elements and/or cooperatively performed by more than one

element of the main processor 300 (and/or other elements of the system 100) without departing from the teachings of the present disclosure. It is also to be understood in the present disclosure that, although the actions, functions, processes, and/or methods performed by the main processor 300 are described in the present disclosure as being performed by particular elements of the main processor 300, the actions, functions, processes, and/or methods performed by two or more particular elements of the main processor 300 may be combined and performed by one element of the main processor 300 without departing from the teachings of the present disclosure.

[00116] In an example embodiment, the main processor 300 performs the above actions/functions and/or other actions/functions described in the present disclosure, via one or more processors of the main processor 300 and/or via calculations, estimations, results, inferences, predictions, or the like, generated and/or derived, directly or indirectly, partially, in cooperation or in whole, by artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes. Such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be part of the main processor 200 and/or the system 100 and may include, but are not limited to, machine learning algorithms, long short term memory (LSTM), reinforce learning technique, etc. Furthermore, such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be provided locally via the main processor 300 (and/or one or more other elements of the system 100) and/or via network 40, cloud computing 40, distributed computing 40, and/or non-localized or decentralized artificial intelligence (AI) 40, and others.

[00117] **Example embodiments of a method for managing a hearing aid (e.g., method 500).**

[00118] As illustrated in at least **FIGURE 5, FIGURE 6 and FIGURE 7**, an example of the first embodiments of a method for managing a hearing aid (e.g., method 500) is disclosed. The method may be configurable or configured to perform (e.g., via the processor 300 or main processor 300) predicting, suggesting, determining, and/or adjusting of a hearing aid (e.g., the hearing aid assembly 200). The method 500 includes one or more processes which may be performed by one or more elements of the system 100 as described in the present disclosure. For example, as will be further described in the present disclosure, the method 500 includes one or more steps to manage the hearing aid assembly through one or more processes performed by one or more elements of the system 100.

[00119] To perform the actions, functions, processes, and/or methods described above and in the present disclosure, example embodiments of the method 500 include one or more steps.

[00120] In an example embodiment, the method 500 for managing the hearing aid device includes establishing a communication channel between a main processor and a hearing aid assembly of the user (e.g., action 510). The method 500 may also include performing an audiogram generation process (e.g., action 520). Example embodiments may be performed using example embodiments of the system for managing the hearing aid assembly of the user, as described above and in the present disclosure. Such system may include, for example, a hearing aid assembly 200 for selectively emitting, transmitting, generating, or the like, audio signals to the user based on instructions received from the processor. The system may also include one or more processors 300 for performing an audiogram generation process and generating optimized predicted compression ratios to be applied to the hearing aid assembly 200. These and other actions will be further described below and in the present disclosure.

[00121] In an example embodiment, the main processor 300 may be, include, and/or form part of a mobile device of the user (e.g., a mobile device, a tablet, a laptop, wearable device such as a smart watch, smart glasses, smart ring, smart pin, etc.). Alternatively or in addition, the main processor 300 may be, include, and/or form part of a central processor or server; distributed computing; cloud computing; etc. Alternatively or in addition, the processor 300 may be integrated with or form part of the hearing aid assembly 200 of the user.

[00122] In an example embodiment, the hearing aid assembly 200 of the user may be and/or include a bone conduction hearing aid device of the user. The communication channel may be or include a wireless communication channel such as those implemented via Bluetooth, Wi-fi, Global Positioning System (GPS), or Wireless Local Area Network (Wireless LAN) technologies.

[00123] In an example embodiment, figure 6 illustrates an example embodiment of the audiogram generation process 520. The audiogram generation process 520 includes receiving surrounding audio information (e.g., action 521). Such receiving of surrounding audio information may be in real-time and/or may be received continuously. The surrounding audio information may include a first surrounding audio information obtained at a first time (e.g., the main processor 300 may be configurable or configured to perform

an example embodiment of the initial audiometry test, as described in the present disclosure, based on the first surrounding audio information). Alternatively or in addition, the surrounding audio information may include a second surrounding audio information obtained at a second time (e.g., after the first time) (e.g., the main processor 300 may be

5 configurable or configured to perform an example embodiment of the subsequent test, as described in the present disclosure, based on the second surrounding audio information). The performing an audiogram generation process 520 may also include one or more other actions, including performing an initial audiometry test (e.g., action 522); receiving initial audiometry test results based on the initial audiometry test (e.g., action 523); generating an

10 audiogram for the user based on surrounding audio information and the initial audiometry test results; generating an initial compression ratio for the user based on the audiogram for the user; generating an insertion gain for the user based on the audiogram for the user; generating a predicted compression ratio for the user based on the generated initial compression ratio for the user (in example embodiments, the generating of the predicted

15 compression ratio for the user is also based on the generated insertion gain for the user); performing a subsequent test (e.g., action 524); receiving subsequent test results (e.g., action 525); generating an optimized predicted compression ratio (e.g., action 526); and applying the optimized predicted compression ratio for the user (e.g., action 527).

[00124] In an example embodiment, action 521, action 522, and action 523 may be

20 performed by the hearing aid assembly 200 in communication with an example embodiment of the audiometric processor 320. Furthermore, an example embodiment of action 524, action 525, action 526, and action 527 may be performed via the hearing aid assembly 200 in communication with an example embodiment of the compression ratio tuner processor 350.

25 [00125] In regards to example embodiments of receiving surrounding audio information (e.g., action 521), the information on surrounding audio may be a real-time audio information of a surrounding environment. The surrounding audio information may also include, but is not limited to, at least one of the following information: date, time, pressure, humidity, geolocation, pressure, etc. In the example embodiment, the surrounding

30 audio information may be obtained, collected, received, or the like, from the hearing aid assembly of the user and/or the processor. The surrounding audio information may be received from, for examples, but not limited to, Global Positioning System (GPS) on iOS

or Android operating system, or a sound capturing element such as a microphone and/or sensor installed in the hearing aid assembly 200.

[00126] The surrounding audio information may include a first surrounding audio information obtained at a first time, wherein the main processor 300 performs an example embodiment of the initial audiometry test based on the first surrounding audio information. Alternatively or in addition, the surrounding audio information may include a second surrounding audio information obtained at a second time after the first time, wherein the main processor 300 performs an example embodiment of the subsequent test based on the second surrounding audio information. Alternatively or in addition, the main processor 300 may perform an example embodiment of the subsequent test based on the first and second surrounding audio information.

[00127] In regards to example embodiments of performing an initial audiometry test (e.g., action 522), the initial audiometry test for the user, performed via the hearing aid assembly 200 in communication with the audiometric processor 220, includes, but is not limited to, emitting (or transmitting) a signal having a frequency from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches. The initial audiometry test for the user may also include receiving an indication of whether the user is able to hear the signal in each frequency. The initial audiometry test for the user may also include analyzing a hearing condition of the user for each frequency based on the results of the initial audiometry test. In an example embodiment, the initial audiometry test may include between 2-20 batches, and each batch may include an increase for a period of 10-500 milliseconds, followed by a period of 10-500 milliseconds of silence between batches.

[00128] In regards to example embodiments of generating an audiogram for the user, such audiogram for the user is generated based on at least the surrounding audio and the initial audiometry test results. The initial compression ratio for the user is then generated based on the audiogram for the user. Furthermore, a predicted compression ratio for the user is generated based on the initial compression ratio for the user. In example embodiments, an insertion gain (which is generated based on the audiogram for the user) is also used in generating the predicted compression ratio for the user.

[00129] In an example embodiment, the audiometry test for the user, performed via the hearing aid device 200 in communication with the audiometric processor 320, includes use of other information, including a hearing condition of the user, overall health condition of the user, etc.

[00130] In an example embodiment, the initial audiometry test is performed by using pure tone audiometry, speech audiometry, speech-in-noise test, noise-masked pure tone audiometry, etc.

[00131] In an example embodiment, in terms of the audiogram generation process (e.g., action 520), the audiogram generation process also includes storing (e.g., on a cloud system, centralized database system, locally on the processor, etc.) the initial compression ratio for artificial intelligence model training (in addition to use for generating the predicted compression ratios for the user).

[00132] In regards to example embodiments of perform the subsequent test (e.g., 524), the surrounding audio information and the initial audiometry test results are used in performing the subsequent test for the user. The subsequent test includes applying the generated predicted compression ratio for the user to the surrounding audio information. Subsequent test results for the user based on the subsequent test performed for the user are then obtained, and an optimized predicted compression ratio for the user is generated based on the subsequent test results. Once the optimized predicted compression ratio for the user is generated, an example embodiment of the method 500 includes applying, to the hearing aid assembly 200, the optimized predicted compression ratio for the user.

[00133] In an example embodiment, the perform of a subsequent test (e.g., action 524) also includes receiving one or more feedback from the user. Such feedback may include one or more textual inputs from the user (e.g., describing a result of the applying of the generated predicted compression ratio to the surrounding audio). For example, the user may provide textual inputs describing the audio generated such as typing the word "loud" when the user hears loud (or high volume) generated sound. In an example embodiment, the textual inputs are provided as input to a model (e.g., a large language model (LLM), which may be configured to capture a word context and predict a weighing factor of each set of the audio sound).

[00134] Alternatively or in addition, the feedback may also include one or more ratings from the user. The ratings may include, for example, an indication of whether the result of applying the generated predicted compression ratio to the surrounding audio resulted in changes. For example, the user can indicate the types and/or quality of sounds heard by the user (e.g., clearer audio, muffled audio, loud audio, and/or dimmed audio). In an example embodiment, the rating may be provided and/or described as a scale to

determine a discount coefficient for further predicting an adjusted predicted compression ratio.

[00135] In an example embodiment, the performing of a subsequent test (e.g., action 524) may include performing one or more additional subsequent tests for the user after performing the subsequent test for the user. The performing of the additional subsequent test(s) may include performing a second subsequent test for the user, and receiving second subsequent test results based on the second subsequent test performed for the user. The performing of the second subsequent test for the user may include applying the optimized predicted compression ratio for the user to the surrounding audio information, and arriving at a second subsequent test result. A second optimized predicted compression ratio for the user may then be generated based on the second subsequent test results. In this regard, the second optimized predicted compression ratio for the user may then be applied to the hearing aid assembly.

[00136] In an example embodiment, the main processor 300 may be, form a part of, or include a mobile device of the user (e.g., a mobile device, a tablet, a laptop, a wearable device, etc.).

[00137] Alternatively or in addition, the main processor may be integrated with or form part of the hearing aid assembly 200 of the user.

[00138] In an example embodiment, the hearing aid assembly 200 of the user may be, but not limited to, a bone conduction hearing aid assembly of the user.

[00139] In an example embodiment, the communication channel may be or include a wireless communication channel including, but not limited to, Bluetooth, Wi-fi, Global Positioning System (GPS), or Wireless Local Area Network (Wireless LAN).

[00140] In an example embodiment, the surrounding audio information may include historic audio information. The historic audio information may be or include audio information previously obtained from a geolocation, location, vicinity, area, landmark, or the like, that is within a threshold distance from a current location of the user.

[00141] In an example embodiment, the surrounding audio information includes historic audio information previously obtained from a geolocation that is within a threshold area from a current location of the user.

[00142] In an example embodiment, the surrounding audio information includes audio information generated by and/or based on artificial intelligence, as described in the present disclosure.

[00143] In an example embodiment, the method 500 may include storing the initial compression ratio, the predicted compression ratio, and/or the optimized predicted compression ratio for artificial intelligence model training. The predicted compression ratio and/or the optimized predicted compression ratio may also be based on the artificial intelligence model training.

[00144] In an example embodiment, figure 7 illustrates an example embodiment of the main processor 300 (e.g., mobile device) for managing a hearing aid assembly of the user, as described above and in the present disclosure.

[00145] Firstly, the processor prompts users who have not yet registered to register by pressing the "Register" button on the screen and filling out information (e.g., name, email, password, confirmed password, and age of the user). Once registration is completed, the processor is configurable or configured to establish a communication channel with the user's hearing aid assembly 200 (e.g., bone conduction hearing aid), such as via Bluetooth. The main processor 300 will commence performing the method 500 upon the user pressing the "Test" button, or the like, to collect, identify, and/or receive data from the user on the system (e.g., hearing condition, surrounding and/or environmental audio, geolocation, date/time, temperature, pressure, humidity, historical information of one or more of the above, etc.). Hearing condition information may include sensorineural, single-side deafness, and conductive or mixed condition, which is stored. In example embodiments, the processor may command the hearing aid assembly to collect, receive, obtain, or the like, surrounding or environmental sounds at the current/present user's location, which are stored.

[00146] The main processor 300 may then prompt the user to start performing an initial test (e.g., a pure tone audiometry test). Parameters, such as frequencies, periods, number of batches, and how to measure the average hearing threshold, may be selectively adjusted in each hearing aid device by the processor, user, or hearing aid assembly, or may be set as a default value.

[00147] In an example embodiment, the signals emitted by the hearing aid assembly pursuant to the initial audiometry test may be grouped, separated, split, or the like, into batches (e.g., 2-20 batches; or preferably about 9-10 batches). Each batch may contain one or more frequencies (e.g., 1-10 frequencies; or preferably, 2-4 frequencies). As an example, the frequencies may include 125 Hz, 250 Hz, 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, 6000 Hz, and/or 8,000 Hz for a period of 200 to 800 milliseconds. In an example embodiment, the main processor 300 is configured in such a way that the frequencies of the

signals generated by the hearing aid assembly in a subsequent (or next) batch may contain the last two frequencies of a previous batch, along with new higher frequencies. For example, if batch 1 includes signals with frequencies of 125 Hz, 250 Hz, and 500 Hz, then a subsequent batch (batch 2) may include signals with frequencies of 250 Hz, 500 Hz, and 1000 Hz. For the signals in each batch, the volume of each signal may also gradually increase for a period (e.g., 50-200 milliseconds; or preferably 100 milliseconds), followed by a period of silence (e.g., 50-200 milliseconds; or preferably 100 milliseconds). The user may be prompted to press and hold a button displayed on the processor once they hear a beeping tone. While the button is held, an example embodiment of the main processor 300 may be configurable or configured to command the hearing aid assembly 200 to gradually decrease the volume. The user is requested to release the button as the beeping tone subsides. If the volume exceeds a set threshold value, a masked noise is emitted to the opposite ear to prevent crossovers for assisting the determination of true hearing threshold in the presence of competing sounds. This process records higher and lower boundaries for which true value of hearing threshold lies. In an example embodiment, the user may be required to go through the several trials (e.g., 10-40 trials; or preferably 25-29 trials), with 3 data points for each frequency band. The results are then used to calculate an average hearing threshold. The pure tone audiometry results are stored on a cloud system.

[00148] When the pure tone audiometry is completed, the processor is configurable or configured to display for the user in order to start rating preferred audio. Preferred audio can be rated by pressing one of several buttons (e.g., 4 buttons such as "Audio A", "Audio B", "Audio A and B", and "Audio A and B not preferred", where Audio A refers to sound that the first predicted compression ratio applied to local surrounding audio, and Audio B refers to sound that the second predicted compression ratio applied to local surrounding audio).

[00149] When the rating of preferred audio is complete, the processor is configurable or configured to prompt the user to start the feedback session. The feedback of the sound can be performed by several methods, including textual input and spatial axis ratings. When the user select textual input, the user is requested to provide textual feedback of a sound. The textual feedback is processed by using a Large Language Model (LLM) by capturing the word context and predict the weighing factor of importance for each set of compression ratios. On the other hand, when the user select spatial axis ratings, the user is prompted to provide feedback of a sound by plotting the subjective feedback including soft, loud,

muffled, clear, etc. to determine a discount coefficient to predict an adjusted compression ratio and/or hearing parameters. Both types of feedbacks are stored.

[00150] In an example embodiment, the method 500 for managing the hearing aid device may include applying the active learning approach to the system 100. Furthermore,
5 the example embodiment as used in the present disclosure is for the purpose of describing example embodiments only and is not intended to be limitations.

[00151] In an example embodiment, the step of performing an initial audiometry test may also include the step of receiving a predicted compression ratio, the step of generate prediction confidence; and the step of determining the predicted compression ratio having
10 the least value of prediction confidence.

[00152] For examples, the main processor 300 will select one or more predicted compression ratio, and generate one or more the prediction confidence. The prediction confidences are accumulated in database. Once the main processor 300 receive other predicted compression ratios, the main processor 300 determine the predicted compression
15 ratio having the least value of prediction confidence, and sent the said predicted compression ratio to the step of receiving the initial audiometry test results to further perform the sequent test for determining the optimized predicted compression ratio.

[00153] In an example embodiment, the method 500 for managing the hearing aid device may include applying the supervised learning approach to the system 100.
20 Furthermore, the example embodiment as used in the present disclosure is for the purpose of describing example embodiments only and is not intended to be limitations.

[00154] In an example embodiment, the step of performing an initial audiometry test may also include the step of selecting the audiogram from the user which is similar to the audiogram from the other user .

25 [00155] For examples, the User A is first compared the information with the User B. Such the information may include, but not limited to, unclassified audiograms, classified audiogram compression ratios, insertion grains, or parameters. The unclassified audiograms from User A and User B may be classified to, for examples, 10 classes. The main processor 300 will select the information from the user A which is similar to the information from the
30 user B, and sent the said similar information to the step of receiving the initial audiometry test results to further perform the sequent test for determining the optimized predicted compression ratio.

[00156] In an example embodiment, the method 500 for managing the hearing aid device may be performed, some part or all parts, via the application in the mobile device. Furthermore, the example embodiment as used in the present disclosure is for the purpose of describing example embodiments only and is not intended to be limitations.

5 [00157] Firstly, a user opens the application on a user device 10. For the first time of the user using the application, the user have to register by pressing the "Register" button on the screen and filling out information, such as, name, email, password, confirmed password, and age of the user. Once the registration completed, the application then is connected to user's hearing aid device 200 via the network 40 (i.e., Bluetooth). Once the registration
10 completed, the screen on the application displays the user's name. The user then press "Test" button to collect data from the user on the system. The basic information will be provided from the user, including a hearing condition, environmental audio, geolocation, date/time, temperature, pressure, humidity. The hearing condition is selected form sensorineural, single-side deafness, conductive or mixed condition, and then the hearing condition are
15 stored in a database. The application will be connected to the GPS to discover your geographic location in the user's current/present location for identifying, for example, geolocation, date/time, temperature, pressure, or humidity, and then such information are also stored in the database. The application will then connect to the microphone on your hearing aid device to receive environmental sounds at the current/present user's location,
20 convert to audio frequency, and are stored in the database.

[00158] For the next step, the screen on the application shows the display for the user in order to start performing the pure tone audiometry test which includes the following procedures. Parameters, for examples, frequencies, periods, numbers of batch, and how to measure the average hearing threshold are the examples in present embodiment, and can be
25 appropriately adjusted in each hearing aid device.

[00159] In the example embodiment, the signals emitted by the audiometry test are split into 9 (or more or less) batches, each containing 3 (or more or less) frequencies. The signals may have frequencies of 125, 250, 500, 1000, 2000, 3000, 4000, 6000, and 8,000 Hz for a period of 200 to 800 milliseconds. The frequencies of the signals in a subsequent
30 batch contains the last two frequencies of the previous batch, plus new higher frequencies. For example, batch 1 = [125, 250, 500 Hz], batch 2 = [250, 500, 1000 Hz]. For the signals in each batch, the volume of each signal gradually increases for a period of 100 milliseconds, followed by 100 milliseconds of silence. The user will be requested to press and hold the

button once they hear the beeping tone. While the button is held, the volume will gradually decrease and the user is requested to release the button as the beeping tone subsides. If the volume exceeds a set threshold value, a masked noise is emitted to the opposite ear to prevent crossovers for assisting the determination of true hearing threshold in the presence of competing sounds. This process records higher and lower boundaries for which true value of hearing threshold lies. The user will go through the 27 trials and the 3 data points for each frequency band. The results are then used to calculate an average hearing threshold. The pure tone audiometry results are stored on a cloud system.

[00160] When the pure tone audiometry finished, the screen on the application shows the display for the user in order to start the rating preferred audio. The preferred audio can be rated by press one of the 4 buttons on the screen, including "Audio A", "Audio B" "Audio A and B" and "No Audio prefer", where Audio A refers to sound that the first predicted compression ratio applied to local surrounding audio, and Audio B refers to sound that the second predicted compression ratio applied to local surrounding audio. The user can also listen Audio A and Audio B again by pressing the button of the amplifier. In case the user select the button, the audio data will be stored in the cloud system, and "Audio A" and "Audio B" will be once generated for the rating preferred audio.

[00161] When the rating preferred audio finished, the screen on the application shows the display for the user in order to start the feedback session. The feedback of the sound can be performed by two methods: textual input or spatial axis ratings. When the user select the textual input, press the "Textual Input", and then the user provide the feedback of the sound by typing the types of the sound. The typing will be processed by using a Large Language Model (LLM) by capturing the word context and predict the weighing factor of importance for each set of compression ratios. When the user select the spatial axis ratings, press the "spatial axis", and then the user provide the feedback of the sound by plotting the subjective feedback including soft, loud, muffled, clear, etc. to determine a discount coefficient to predict an adjusted compression ratio and/or hearing parameters. The both feedbacks are accumulated on the cloud system. When the feedback of the sound finished, the screen on the application returns to the user's profile screen.

[00162] Once the feedback of the user is positive and no longer requires further adjustments, the user will press the button "Adjustment". The application will then identify a geolocation of the user and collect surrounding or environmental sounds at the current/present user's location. Finally, the screen on the application shows the display

"Automatic Adjustment Completed" which is the final process of the adjustment of the hearing aid device.

[00163] Example embodiments of another overall system for a hearing aid system (e.g. system 800).

5 **[00164]** As an overview, an example of another embodiment of a hearing aid system (e.g., system 800) is illustrated in **FIGURE 8**. The system 800 may include and/or manage one or more elements, including one or more hearing aid assemblies 200, 900 and/or one or more main processors 300, 1000 (also referred to herein as a processor). The system 800 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, to improve or enhance hearing aid system. For example, the system 800 is configurable or configured to perform one or more audiometry tests, or the like, using an example embodiment of the audiometric processor 220, 920 integrated with the hearing aid assembly 200, 900. The system 800 is also configurable or configured to collect information of a user's audiometry test results, and perform an artificial intelligence (AI) model training based on the user's audiometry test results to train a trained/untrained AI model and/or arrive at a trained AI model. The system 800 is also configurable or configured to generate predicted compression ratios and/or other predicted hearing parameters for the user, facilitate adjustment and/or calibration of the hearing aid assembly 200, 900, facilitate a tuning or adjusting process for the hearing aid assembly 200, 900, and/or perform predictions for the hearing aid assembly 200,900 to achieve, among other things, an optimum hearing experience for the user based on audio information of a surrounding environment (e.g., real-time audio information, near real-time audio information, and/or historic information).

15 **[00165]** The system 800 includes a hearing aid assembly 200, 900. The hearing aid assembly 800 is configurable or configured to be securable to a user. The hearing aid assembly 200, 900 includes one or more hearing aid transceiver assemblies and/or one or more digital signal processors. These elements, which are further described in the present disclosure, may be in communication with one or more elements of the system 800 (including each other) to manage the user's hearing capability. The hearing aid transceiver assembly (e.g., hearing aid transceiver assembly 210, 910) is configurable or configured to selectively emit audio signals to the user (e.g., based on instructions received from one or more elements of the system 800 and/or the user). The instructions received by the hearing aid transceiver assembly 210, 910 may include instructions to perform an audiometry test,

or the like. The audiometry test may include, for example, pure tone audiometry tests, speech audiometry, speech-in-noise tests, and/or noise-masked pure tone audiometry tests. The audio signals emitted by the hearing aid transceiver assembly 210, 910 may include, for example, pure tone signals. The hearing aid transceiver assembly 210, 910 is also

5 configurable or configured to obtain surrounding audio information. The surrounding audio information may include real-time, near real-time, and/or historic audio-related information of a surrounding environment of the hearing aid assembly 800 and/or the user. The hearing aid assembly 200, 900 may also include a digital signal processor (e.g., digital signal processor 920). The digital signal processor 920 is configurable or configured to perform

10 an example embodiment of a surrounding audio adjustment process. The digital signal processor 920 may include an environment classifier to classify a surrounding audio (e.g., audio of a surrounding environment of the hearing aid assembly 800 and/or the user). The digital signal processor 920 is configurable or configured to adjust one or more audio processing parameters of surrounding audio (e.g., surrounding audio as received, identified,

15 detected, captured, recorded, obtained, or the like, by the hearing aid assembly 800) to generate an audio output, and such adjusting of one or more audio processing parameters may be performed based on one or more factors or information, including the environment classifier and a hearing profile of the user (e.g., and may also include information received from and/or obtained by one or more other elements of the system 800).

20 **[00166]** The system 800 also includes one or more main processors 300, 1000. The main processor 300, 1000 is configurable or configured to communicate with the hearing aid assembly 200, 900 and/or one or more other elements of the system 800. The main processor 300, 1000 includes one or more audiometric profile processors, one or more hearing profile processors, and/or one or more parameter optimization processors. These

25 elements, which are further described in the present disclosure, may be in communication with one or more elements of the system 800 (including each other) to process information received from the hearing aid assembly 200 and/or one or more other elements of the system 800. For example, such processing of information received from the hearing aid assembly 200 may be processed using an artificial intelligence (AI) model, or the like. The

30 audiometric profile processor (e.g., audiometric profile processor 1010) is configurable or configured to perform an example embodiment of an audiogram generation process. The audiometric profile processor 1010 is configurable or configured to cooperate with the hearing profile processor 1020 and/or one or more other elements of the system 800 to

perform an audiometry test, or the like, on the user. After an audiometry test is performed, the audiometric profile processor 1010 is configurable or configured to receive audiometry test results (e.g., which may include one or more hearing thresholds identified for the user). The audiometric profile processor 1010 is configurable or configured to generate an audiometric profile, or the like, based on such hearing thresholds of the user. The audiometric profile processor 1010 is configurable or configured to send the audiometric profile to an example embodiment of the hearing profile processor 1020.

5 [00167] The main processor 300 also includes a hearing profile processor (e.g., hearing profile processor 1020). The hearing profile processor is configurable or configured to receive the audiometric profile from example embodiments of the audiometric profile processor 1010. The hearing profile processor 1020 is configurable or configured to generate a hearing profile for the user based on the audiometric profile (e.g., by processing (which may include implementing algorithms to) the audiometric profile). By doing so, the hearing profile processor 1020 is configurable or configured to determine one or more hearing parameters (e.g., compression ratio, insertion gain including soft gain, moderate gain, or loud gain, or any other hearing/audio/signal processing parameters). In an example embodiment, the hearing profile processor 1020 is configurable or configured to store such parameters (e.g., compression ratio, insertion gain including soft gain, moderate gain, or loud gain, or any other audio/signal processing parameters) for further processing (e.g., via artificial intelligence model training and/or improving, etc.). The hearing profile processor 1020 is also configurable or configured to determine one or more thresholds for one or more parameters (e.g., for one or more of the following parameters: compression ratio, insertion gain including soft gain, moderate gain, or loud gain, or any other hearing/audio/signal processing parameters). The determination may be based on one or more characteristics of the surrounding audio received by the hearing aid assembly 200, 900 and/or the audiometric profile. The hearing profile processor 1020 is configurable or configured to send the generated hearing profile to the hearing aid assembly 200, 900 to perform an example embodiment of the surrounding audio adjustment process to arrive an audio output for the user.

25 [00168] As will be further described in the present disclosure, the hearing aid assembly 200, 900 is configurable or configured to amplify sounds that are programmed to suit, match, compensate, or the like, the level of hearing loss detected, measured, identified, or the like, in the user. In example embodiments, the hearing aid assembly 200, 900 is also

configurable or configured to communicate with, establish a connection with, and/or include a link to (e.g., a communication channel) a user device 10. Alternatively or in addition, the hearing aid assembly 200, 900 is configurable or configured to communicate with, establish a connection with, and/or include a link to a main processor 300, 1000 (as described in the present disclosure, in example embodiments, the main processor 300, 1000 may be, form part of, include, or the like, the user's mobile device; the main processor 300, 1000 may also be or include a central processor, cloud computing, etc.).

[00169] The hearing aid assembly 200, 900 may include and/or communicate with one or more user devices 10 (e.g., via a mobile application of the user mobile device (referred to interchangeably herein as a "user device mobile application", "mobile application", "mobile device", "main processor", or "processor")). Such user device mobile application may include and/or be installed and run/executed on, for example, mobile devices, tablet devices, wearable devices, laptop or other portable computing devices, desktop or other non-portable computing devices, cloud computing devices, and/or the like. Each user device mobile application is configurable or configured to communicate, directly or indirectly, with one or more main processors 300, 1000, hearing aid assembly 200, 900, database 40, and/or one or more other elements of the system 100. For example, the user device mobile application is configurable or configured to send or transmit (e.g., via network) user's feedback to audiometry test.

[00170] As will be further described in the present disclosure, each main processor 300, 1000 is configurable or configured to manage and/or control one or more hearing aid assemblies 200, 900. In example embodiments, each main processor 300, 1000 may also be configurable or configured to manage and/or control one or more user device 10. Each main processor 300, 1000 is configurable or configured to manage, connect and/or communicate directly or indirectly one or more databases 40 (e.g., central databases, distributed or non-centralized databases, cloud computing, blockchain, etc.). Each main processor 300, 1000 may also be configurable or configured to perform one or more aspects of an audiogram generation process, as described in the present disclosure. Each main processor 300, 1000 may also be configurable or configured to receive the surrounding audio information and the audiometry test results for the user from the hearing aid device 200, 900. Each main processor 300, 1000 may also be configurable or configured to generate one or more audiograms for the user based on the received audiometry test results. Each main processor 300, 1000 may also be configurable or configured to generate one or more prescriptive

insertion gains for the user. Each main processor 300, 1000 may also be configurable or configured to generate one or more initial compression ratios for the user. Each main processor 300, 1000 may also be configurable or configured to generate one or more predicted compression ratios. Each main processor 300, 1000 may also be configurable or configured to perform one or more aspects of a compression ratio tuning process as described in the present disclosure. Each main processor 300, 1000 may also be configurable or configured to apply the generated predicted compression ratios and/or generated predicted hearing parameter for the user to the surrounding audio information to arrive at one or more compressed surrounding audio. Each main processor 300, 1000 may also be configurable or configured to receive feedback from the user on the one or more compressed surrounding audio. Each main processor 300, 1000 may also be configurable or configured to assess the feedback from the user on the one or more compressed surrounding audio to arrive at one or more feedback data. Each main processor 300, 1000 may also be configurable or configured to perform an AI model training using the compressed surrounding audio and the feedback data to arrive at a trained AI model. Each main processor 300, 1000 may also be configurable or configured to responsive to receiving a real-time surrounding environmental audio.

[00171] The system 800 may also include and/or communicate with one or more networks, communication channels, or the like. Each network is configurable or configured to enable communications between one or more elements of the system 800. For example, the network may be configurable or configured to enable one or more hearing aid devices 800 to send the audiometry test results to a main processor 300, 1000. As another example, the network may be configurable or configured to enable the main processor 300, 1000 to perform the compression ratio tuning based on AI model. In yet another example, the network may be configurable or configured to enable one or more user device mobile application to communicate with one or more database 40. In yet another example, the network may be configurable or configured to enable one or more hearing aid device 800 to perform the audiometry test. communicate with one or more database 40. In yet another example, the network may be configurable or configured to enable one or more hearing aid device 100 to communicate with one or more database.

[00172] It is to be understood in the present disclosure that, although the functions and/or processes performed by the system are described in the present disclosure as being performed by particular element(s) of the system, the functions and/or processes performed

by a particular element of the system 800 may also be performed by one or more other elements and/or cooperatively performed by more than one element of the system 800 without departing from the teachings of the present disclosure. It is also to be understood in the present disclosure that, although the functions and/or processes performed by the system 800 are described in the present disclosure as being performed by particular elements of the system 800, the functions and/or processes performed by two or more particular elements of the system 800 may be combined and performed by one element of the system 100 without departing from the teachings of the present disclosure.

[00173] As used in the present disclosure, when applicable, a reference to a system (e.g., system 800), processor (e.g., main processor 300, 1000), elements of a system 800 and/or main processor 300, 1000, or the like, may also refer to, apply to, and/or include a computing device, processor, server, system, cloud-based computing, or the like, and/or functionality of a processor, computing device, server, system, cloud-based computing, or the like. The system 800 and/or main processor 300, 1000 (and/or its elements, as described in the present disclosure) may be any processor, server, system, device, computing device, controller, microprocessor, microcontroller, microchip, semiconductor device, or the like, configurable or configured to perform, among other things, a processing and/or managing of information, data communications, user requests, hashing of information, encryption and decryption of information, creating digital signatures, and/or any other actions described above and in the present disclosure. Alternatively or in addition, the system 800 and/or main processor 300, 1000 (and/or its elements, as described in the present disclosure) may include and/or be a part of a virtual machine, software, processor, computer, node, instance, host, or machine, including those in a networked computing environment. As used in the present disclosure, a network 40 and/or cloud may be a collection of devices connected by communication channels that facilitate communications between devices and allow for devices to share resources. Such resources may encompass any types of resources for running instances including hardware (such as servers, clients, mainframe computers, networks, network storage, data sources, memory, central processing unit time, scientific instruments, and other computing devices), as well as software, software licenses, available network services, and other non-hardware resources, or a combination thereof. A network 40, communication channel 40, cloud 40, or the like, may include, but is not limited to, computing grid systems, peer to peer systems, mesh-type systems, distributed computing environments, cloud computing environment, etc. Such network 40, communication

channel 40, cloud 40, or the like, may include hardware and software infrastructures configured to form a virtual organization comprised of multiple resources which may be in geographically disperse locations. Network 40 may also refer to a communication medium between processes on the same device. Also as referred to herein, a network element, node, 5 or server may be a device deployed to execute a program operating as a socket listener and may include software instances.

[00174] In an example embodiment, the hearing aid system 800 includes the following components.

[00175] **The user device (e.g., the user device 10).**

10 [00176] An example embodiment of the hearing aid system 800 includes one or more user devices (e.g., user device 10). The user device 10 may be in communication, via network 40, with the database 30, the hearing aid assembly 200, 900, and the main processor 300, 1000. As described in the first embodiment, a user device 10 may be user devices of users 10 (e.g., user 10, or patients 10). The user device 10 may be or include, a mobile 15 device 10, tablet device 10, wearable device 10, laptop or other portable computing device 10, desktop or other non-portable computing device 10, workstation 10, networked computing device 10, virtual computing device 10, virtual instances of a computing device 10, cloud computing device 10, and/or the like.

[00177] As described in the first embodiment, the user device 10 is configurable or 20 configured to communicate with one or more databases 30. The database 30 may also store, but not limited to, information such as user data. The user device 10 may receive (or retrieve) such user data including, but is not limited to, personal data of a user (e.g., name, age, gender, identity, health condition, hearing condition, medical officers in charge, etc.), health information (e.g., hearing condition, medical records, etc.), historical information (e.g., 25 historical medical information, historical medical records, historical medical tests, historical hearing tests, historical hearing tests results, etc.), and/or surrounding audio information.

[00178] Such information received by the user device 10 may be received or retrieved when the main processor 300, 1000 receives a command and/or request to initiate or establish a communication channel between the user device 10, the hearing aid assembly 30 200, 900 and the main processor 300, 1000. The information received by the user device 10 may be received in real-time and/or near real-time. Alternatively or in addition, the information may also be received when there are changes, edits, deletions, additions, updates, etc. to the one or more information of the users 10. The user device 10 may also

be configurable or configured to communicate with the database 30 to update and/or store the one or more information that have gone through changes, edits, deletions, additions, updates, etc.

[00179] The database (e.g., database 30).

- 5 **[00180]** As illustrated in at least figure 8, an example embodiment of a system 800 includes one or more databases (e.g., database 30). The database 30 is configurable or configured to perform a plurality of actions, functions, operations, methods, and/or processes, including managing the hearing aid assembly 200, 900. The database 30 may also be configurable or configured to access, manage, store, receive, edit, change, delete, 10 update, and/or otherwise utilize various information to be used by the system 800 for managing the hearing aid assembly 200, 900.

- [00181]** The system 800 may also include and/or communicate with one or more networks, communication channels, or the like (e.g., communication channels 20), which are used to enable communication between elements of the system 800. The system 800 15 may also include and/or communicate with one or more databases, distributed ledgers, or the like (e.g., database 30) to store, search, and/or retrieve information. For example, the database may manage or store information pertaining to audio or frequency of the surrounding environment and/or other hearing parameters which may affect the user hearing capabilities.

- 20 **[00182]** In an example embodiment, the database 30 may include, but not limited to, information pertaining to surrounding environment, surrounding audio, parameters (e.g., geolocation, date/time, temperature, pressure, humidity, user's hearing condition (e.g., sensorineural, single-side deafness, conductive, mixed, etc.), audiometry test results (e.g., ability to hear, degree or type of hearing loss, hearing scores for each ear, etc.), hearing 25 profile (e.g., hearing parameters, initial compression ratio, personalized hearing profile, etc.), user information, user feedbacks or responses (e.g., spatial axis rating, UI feedback, preference ranking, text input, etc.), and/or user preferences. These information are obtained from the user device 10, the hearing aid assembly 200, 900, and/or the main processor 300, 1000.

- 30 **[00183]** The database 30 may be configurable or configured to store, but not limited to, information such as user data. The user data may include, but is not limited to, personal data of a user (e.g., name, age, gender, identity, health condition, hearing condition, medical officers in charge, etc.), health information (e.g., hearing condition, medical records, etc.),

historical information (e.g., historical medical information, historical medical records, historical medical tests, historical hearing tests, historical hearing tests results, etc..), and/or surrounding audio information.

[00184] In yet another example, the database 30 may be configurable or configured to manage or store the audiometry test results from the pure tone audiometry test which determines higher and lower boundaries for which true value of hearing threshold of the user lies. The database 30 may also be configurable or configured to manage or store information pertaining to amount of volume the user may need to add to each frequency band to compensate for hearing loss. The database 20 may be configurable or configured to store such information for further utilize in predicting user's preferences.

[00185] Although Figure 8 may illustrate one database 30, it is to be understood that the system 100 may include more or less than one database 30 without departing from the teachings of the present disclosure.

[00186] **The network (e.g., network 40).**

[00187] As used in the present disclosure, a network 40 and/or cloud 40 may be a collection of devices connected by communication channels that facilitate communications between the elements of the system 800 and allow for the elements of the system 800 to share resources. Such resources may encompass any types of resources for running instances including hardware (such as servers, clients, mainframe computers, networks, network storage, data sources, memory, central processing unit time, scientific instruments, and other computing devices), as well as software, software licenses, available network services, and other non-hardware resources, or a combination thereof. A network 40 or cloud may include, but is not limited to, computing grid systems, peer to peer systems, distributed computing environments, cloud computing environment, etc. Such network 40 or cloud may include hardware and software infrastructures configured to form a virtual organization comprised of multiple resources which may be in geographically disperse locations. Network 40 may also refer to a communication medium between processes on the same device.

[00188] **The hearing aid assembly (e.g., hearing aid assembly 200).**

[00189] As illustrated in at least **FIGURE 8** and **FIGURE 9**, an example embodiment of the hearing aid system 800 includes one or more hearing aid assemblies (e.g., hearing aid assembly 200, 900). Each hearing aid assembly 200, 900 is configurable or configured to emit sound to the user. To do so, each hearing aid assembly 200, 900 is

configurable or configured to communicate with one or more elements of the system 800, including one or more elements of user device 10, database 20, network 30, main processor 300, 1000, communication channels (not shown), information sources (not shown), etc. For example, the hearing aid assembly 200, 900 may be in communication with the main processor 300, 1000 (e.g., to selectively emit audio signals to the user based on instructions received from the main processor 300, 1000).

[00190] As will be further described in the present disclosure, the hearing aid assembly 200, 900 includes a hearing aid transceiver assembly 210, 910. The hearing aid transceiver assembly 210, 910 is configurable or configured to, among other things, relay sounds/audio/frequency that is present and surrounding the user and/or system 100 to each ear of the user. The hearing aid transceiver assembly 210, 910 also includes at least one sound capturing element (e.g., microphone or sensor; not shown) that is used to receive, obtain, record, capture, relay, or the like, sound from the surrounding environment. The at least one sound capturing element is configurable or configured to capture ambient sound. The sound capturing element is also configurable or configured to receive sound from the surrounding environment.

[00191] As will be further described in the present disclosure, the hearing aid assembly 200, 900 also includes a digital signal processor (e.g., digital signal processor 920). The digital signal processor 920 is configurable or configured to perform, among other things, a surrounding audio adjustment process. Furthermore, the digital signal processor 920 may also include an environment classifier, which may be configurable or configured to classify surrounding audio/sound that is received, obtained, recorded, captured, relayed, or the like, from the surrounding environment.

[00192] Alternatively, the hearing aid assembly 200, 900 includes a main body (housing part) for each ear. The main body may (or may not) include a power/mode button, status indication for the device (e.g., an LED, or the like), volume buttons, and/or a battery charging port. In operation, the main body is configurable or configured to be worn in any known way (e.g. when the hearing aid assembly is a bone conduction hearing aid, the main body is configurable or configured to be worn behind the ear). The hearing aid assembly 200, 900 also includes at least one sound capturing element (not shown), such as microphone and/or sensor, to capture ambient sounds, real-time surrounding audio-related information, information pertaining to date, time, pressure, humidity, geolocation, pressure, etc. The hearing aid assembly 200, 900 may include an amplifier (not shown) to increase

the sound level for better hearing. The hearing aid assembly 200, 900 may also include a speaker (not shown) to deliver the sound/audio (e.g., amplified sound) to the user's ears. The hearing assembly 200, 900 may also include a power source (not shown) to recharge battery that powers the hearing aid system 800.

- 5 [00193] The hearing aid assembly 200, 900 includes one or more main input interfaces. Each main input interface is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The main input interface is also configurable or
10 configured to communicate with one or more elements of the system 800, including one or more hearing aid transceiver assembly 210, 910, one or more databases 20, one or more networks 30, one or more main processor 300, 100 and/or one or more communication channels (not shown). Furthermore, the main input interface is configurable or configured to receive, request, retrieve, and/or obtain information from one or more information
15 sources (e.g., databases and networks) and/or resources (e.g., tools and/or applications).

- [00194] In an example embodiment, the main input interface may be configurable or configured to receive, retrieve, request, obtain, select, filter, and/or route information pertaining to real-time, near real-time, and/or historic surrounding audio-related information of a surrounding environment of the hearing aid assembly 200, 900. The surrounding audio-
20 related information may be received, by the main input interface, from one or more elements of the hearing aid system 800. As described in the present disclosure, surrounding audio-related information may include, but is not limited to, at least one of the following information: frequency, amplitude, date, time, pressure, humidity, geolocation, pressure, etc. The surrounding audio-related information may include any kind of data and/or content that
25 is in, relates to, and/or pertains to an audio/sound signal (which may include sounds/audio like music, communication, speech, or other sound/audio recordings). The surrounding audio information may be received from, for example, but not limited to, a Global Positioning System (GPS) (e.g., on and/or via iOS or Android operating system, etc.). As described in the present disclosure, the main input interface is configurable or configured to
30 communicate with one or more databases 20. The main input interface may also receive, retrieve, request, obtain, select, filter, and/or route information from the database 20. The information from the database 20 may include information pertaining to surrounding environment, surrounding audio, parameters (e.g., geolocation, date/time, temperature,

pressure, humidity, user's hearing condition (e.g., sensorineural, single-side deafness, conductive, mixed, etc.), audiometry test results (e.g., ability to hear, degree or type of hearing loss, hearing scores for each ear, etc.), hearing profile (e.g., compression ratio, insertion gain, hearing parameters, personalized hearing profile, etc.), user information, user
5 feedback or responses (e.g., spatial axis rating, UI feedback, preference ranking, text input, etc.), user preferences, and/or historic information pertaining to any one of the aforementioned.

[00195] In an example embodiment, the hearing aid assembly 200, 900 may also be configurable or configured to communicate and/or cooperate with artificial intelligence (AI),
10 machine learning, and/or deep learning algorithms, including Region Based Convolutional Neural Networks (R-CNN), You Only Look Once (YOLO) and/or any other algorithms which may be used.

[00196] In an example embodiment, the hearing aid assembly 200, 900 includes a hearing aid transceiver assembly 210, 910 and a digital signal processor 920, as will be
15 further described in the present disclosure.

[00197] **The hearing aid transceiver assembly 210 (e.g., hearing aid transceiver assembly 210).**

[00198] As illustrated in at least **Figure 8** and **FIGURE 9**, the hearing aid assembly 200, 900 includes one or more hearing aid transceiver assemblies (e.g., hearing aid
20 transceiver assembly 210, 910). Each hearing aid transceiver assembly 210, 910 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The hearing aid transceiver assembly 210, 910 is also configurable or configured to
25 communicate with one or more elements of the system 100, including one or more elements of user device 10, database 30, network 40, main processor 300, 1000, communication channels (not shown), information sources (not shown), and/or resources (e.g., tools and/or applications), etc.

[00199] In an example embodiment, the hearing aid transceiver assembly 210, 910 is
30 configurable or configured to selectively emit audio/sound signals to the user (e.g., based on instructions received from one or more elements of the system 100). The hearing aid transceiver assembly 210, 910 is also configurable or configured to be integrated into the hearing aid assembly 200, 900 to perform one or more of the following functions:

communicating via wireless communication with or receiving commands or instruction from external devices such as smartphones, computers, software, and other hearing aids. This allows for streaming audio, remote control, wireless communication, AI-based computing, Bluetooth, cloud-based computing, and data synchronization within the hearing aid system 800. The command or instructions may include for instance, an instruction for conducting hearing assessment tests, or the like, such as pure-tone audiometry, speech audiometry, speech-in-noise test, and/or noise-masked pure tone audiometry, etc. For example, as illustrated in Figures 9 and 10, the hearing aid transceiver assembly 210, 910 may be in communication with the audiometric profile processor 1010 to receive a command or instruction to perform the audiometry test on the user. Upon receiving a command, the hearing aid transceiver assembly 210, 910 may emit/provide/deliver the audio signals to the user in the form of pure tone signals.

[00200] Upon receiving a command to perform an audiometry test, the hearing aid transceiver assembly 210, 910 may emit a stimulus (e.g., audio/sound signals) having a frequency from between 125 to 8,000 Hz for a period of between 200 to 800 milliseconds in a plurality of batches. The hearing aid transceiver assembly 210, 910 is then configurable or configured to receive an indication, from the user, on whether the user is able to hear the stimulus in each frequency. The hearing aid transceiver assembly 210, 910 then analyzes a hearing condition of the user for each frequency based on the results of the audiometry test. The audiometry test, when performed by the hearing aid transceiver assembly 210, 910 (or the hearing aid assembly 200, 900) may include, for example, between 2-20 batches, with each batch including an increase in duration for a period of between 10-500 milliseconds followed by a period of between 10-500 milliseconds of silence (e.g., no emitting of a stimulus). In another example, the main processor 300, 1000 may be in communication with the hearing aid transceiver assembly 210, 910 such that the digital signal processor 920 and/or one or more other elements of the system 100 may instruct the hearing aid transceiver assembly 210, 910 to emit audio/sound signals for performing the audiometry tests.

[00201] Alternatively or in addition, the hearing aid transceiver assembly 210, 910 may also be configurable or configured to perform the audiometry test one or more of a variety of hearing test procedures. In an exemplary embodiment, the audiometry test may be performed under Hughson Westlake procedure. By doing so, the hearing aid transceiver assembly 210, 910 may emit a stimulus with an initial level of about 50 dB. The user may be required to provide responses when the user hears the stimulus. If the user does not hear

the stimulus and does not provide a response, the hearing aid transceiver assembly 210, 910 may be configurable or configured to increase the stimulus (e.g., by 20 dB approximately or more) until the user hears the stimulus and provides a response. An initial point where the user can hear the stimulus and provide a response is determined. From such initial point,

5 the hearing aid transceiver assembly 210, 910 may be configurable or configured to reduce a stimulus level in steps (e.g., steps of 10 dB) until the user can no longer hear the stimulus and no longer responds. When the user no longer hears the stimulus and does not respond to the stimulus, the hearing aid transceiver assembly 210, 910 may be configurable or configured to increase the stimulus level in steps (e.g., steps of 5 dB) until the user hears the

10 stimulus and a response is received. Such procedures are performed at each frequency for both ears. The frequencies to be tested may include, for example, 250Hz, 500Hz, 1KHz, 2KHz, 3KHz, 4 KHz, 6 KHz, and 8 KHz,. The hearing aid transceiver assembly 210, 910 may also be configurable or configured to repeat the audiometry test (e.g., three to five times or more) to improve the accuracy of the hearing test results. The hearing test results may

15 be generated as an audiogram. The hearing aid transceiver assembly 210, 910 may also be configurable or configured to store the audiometric test results performed on the user. In another example, the main processor 300, 1000 may be in communication with the hearing aid transceiver assembly 210, 910 such that the digital signal processor 920 may instruct the hearing aid transceiver assembly 210, 910 to perform the procedure described above.

20 **[00202]** The audiometry test results may be used to determine user's ability to hear, hearing health, the degree or type of hearing loss, hearing scores for each ear, and other related metrics. The audiometry test results may also be used to determine a hearing threshold. When determining the hearing threshold, the hearing aid transceiver assembly 210, 910 may also be configurable or configured to repeat the audiometry test multiple times,

25 for example, two, three, four, five, ten times, or more, to enhance the accuracy of the hearing test result. For example, two out of three or three out of five identical hearing test results may be required to determine the hearing threshold. The hearing threshold may be determined from the lowest stimulus the user can hear at various stimulus frequencies (e.g., between 125 to 8,000 Hz). After determining the hearing test result, the hearing aid

30 transceiver assembly 210, 910 may be configurable or configured to send the hearing test result to the main processor 300, 1000 and/or one more elements of the system 800 for further generating of an audiometric profile based on the hearing thresholds of the user.

[00203] In an example embodiment, the hearing aid transceiver assembly 210, 910 is also configurable or configured to obtain surrounding audio information. The surrounding audio information may include real-time surrounding audio-related information of a surrounding environment of the hearing aid assembly 200, 900. The surrounding audio information may be received from, for example, but not limited to, a Global Positioning System (GPS) (e.g., via or on iOS or Android operating system) or a sound capturing element such as a microphone and/or sensor installed in the hearing aid assembly 200, 900. The surrounding audio information may include information relating to ambient sound or background sound (e.g., from nature, city, indoor or outdoor environments, vehicle mode, factories, theaters, sports clubs, schools, offices, markets, vehicles, music, or human activity, etc.) that are present in a location where the user is situated. The surrounding audio information may include, but is not limited to, at least one of the following information: date, time, pressure, humidity, geolocation, pressure, etc. The surrounding audio-related information may include any kind of data and/or content that is in, associated with, and/or pertains to an audio/sound signal (such audio/sound signals may include music, communication, speech, or other audio recordings). Alternatively or in addition, the hearing aid transceiver assembly 210, 910 may convert the surrounding audio information to an electrical representation of the audio/sound (sounds within human hearing range). The hearing aid transceiver assembly 210, 910 may also be configurable or configured to present the surrounding audio information in a variety of different forms, including analogue signals, digital signals, continuous waveforms representing sound pressure variations, digital signals composed of binary data, etc.

[00204] In an example embodiment, the hearing aid transceiver assembly 210, 910 is configurable or configured to communicate, cooperate and/or connect with one or more user device 10. The user device 10 may be or include, mobile device 10, tablet device 10, wearable device 10, laptop or other portable computing device 10, desktop or other non-portable computing device 10, workstation 10, networked computing device 10, virtual computing device 10, virtual instances of a computing device 10, cloud computing device 10, and/or the like. For example, the hearing aid transceiver assembly 210 may be in communication to the mobile device such that the mobile device allows the user to adjust settings such as volume, sound modes, and connectivity options through a companion application or direct controls on the mobile device.

[00205] In an example embodiment, the hearing aid transceiver assembly 210, 910 may also be configurable or configured to communicate, connect and/or cooperate with one or more database 30. The hearing aid transceiver assembly 210, 910 may also be configurable or configured to receive, retrieve, request, obtain, and/or route information
5 from the database 30. The information from the database 30 may include information pertaining to surrounding environment, surrounding audio, parameters (e.g., geolocation, date/time, temperature, pressure, humidity, user's hearing condition (e.g., sensorineural, single-side deafness, conductive, mixed, etc.), audiometry test results (e.g., ability to hear, degree or type of hearing loss, hearing scores for each ear, etc.), hearing profile (e.g., hearing
10 parameters, initial compression ratio, personalized hearing profile, etc.), user information, user feedbacks or responses (e.g., spatial axis rating, UI feedback, preference ranking, text input, etc.), and/or user preferences.

[00206] The hearing aid transceiver assembly 210, 910 is also configurable or configured to communicate with one or more digital signal processors 920, as will be further
15 described in the present disclosure.

[00207] **The digital signal processor (e.g., digital signal processor 920).**

[00208] As illustrated in at least **Figure 10**, the hearing aid assembly 200, 900 includes one or more digital signal processor (e.g., digital signal processor 920). Each digital signal processor 920 is configurable or configured to perform one or more of a plurality of
20 functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The digital signal processor 920 is also configurable or configured to communicate with one or more elements of the system 800, including one or more elements of user device 10, database 20, network 30, hearing aid transceiver assembly
25 210, 910, main processor 300, 1000, communication channels (not shown), information sources (not shown), and/or resources (e.g., tools and/or applications), etc.

[00209] In an example embodiment, the digital signal processor 920 is configurable or configured to perform a surrounding audio adjustment process. The digital signal processor 920 is configurable or configured to perform or enable dynamic modification of
30 audio signals based on acoustic characteristics of the user's environment. The digital signal processor 920 is configurable or configured to generate an adjusted or optimized audio/signal output by applying signal processing algorithms including those pertaining to, but not limited to, wide dynamic range compression, noise reduction, gain control,

frequency shaping, and feedback cancellation. The one or more adjustments may be based on real-time, near real-time, and/or non-real-time (e.g., historic) surrounding audio information. The digital signal processor 920 may utilize audio processing parameters derived and/or obtained from one or more sources, including surrounding audio information captured by the hearing aid assembly 200, 900 or the hearing aid transceiver assembly 210, 910. Alternatively or in addition, the digital signal processor 920 may also utilize audio processing parameters derived or obtained from the user's active, existing, and/or pre-configured hearing profile. Alternatively or in addition, the digital signal processor 920 may also utilize audio processing parameters derived or obtained from the user's feedback which may be collected from the user manually via a user interface (e.g., user interface having user guided control elements or adaptive learning mechanisms) of the system 800.

[00210] In yet another embodiment, the digital signal processor 920 is configurable or configured to communicate with the hearing aid transceiver assembly 210, 910 via a wireless communication protocol. The hearing aid transceiver assembly 210, 910 may be configurable or configured to receive audio/sound signals (e.g., ambient audio signals) from the surrounding environment of the user and transmit corresponding audio-related data to the digital signal processor 920. The surrounding audio information may include characteristics of ambient sound, background noise, speech patterns, and/or other acoustic features present in the user's location. The digital signal processor 920 is configurable or configured to also further adjust or optimize the audio/sound or signal output based on these information. Once the surrounding audio information is received, the digital signal processor 920 may be configurable or configured to determine one or more environment classifiers based on the characteristics of the received surrounding audio information. The environment classifier may be determined by an example embodiment of a environment classifier module (e.g., environment classifier module 922), which may be integrated within or operatively connected to the digital signal processor 920. The environment classifier module 922 may be configurable or configured to analyze acoustic features of the surrounding audio and classify the user's environment into one or more categories (e.g., categories may include, but are not limited to, quiet, noisy, speech-in-noise, music, outdoor, etc.). The environment classifier is used, together with the user's hearing profile (either active, existing or pre-configured), to dynamically adjust or optimize the audio processing parameters within the digital signal processor 920. These adjustments may include, but are not limited to, wide dynamic range compression, gain control, directional microphone

steering, noise suppression levels, frequency shaping, etc.. Such adjustments are applied to optimize the audio or signal output for the specific acoustic environment where the user is situated.

[00211] In addition to the environment classification, the digital signal processor 920 may be further configurable or configured to communicate with a hearing profile processor (e.g., hearing profile processor 1020) to generate a personalized hearing profile. The personalized hearing profile may be generated in a variety of ways. The digital signal processor 920 includes a parameter application module (e.g., parameter application module 924). The parameter application module 924 is configurable or configured to adjust audio processing parameters based on the environment classifier and the hearing profile. The adjustments may be applied by the parameter application module 924 to the surrounding audio information to generate an adjusted or optimized audio or signal output for playback to the user. The parameter application module 924 may be configurable or configured to perform adjustments, optimization or modification to the audio signals (surrounding audio information) in a variety of ways. For example, the parameter application module 924 may adjust using one or more algorithms including insertion gain adjustment, compression ratio control, feedback cancellation, volume regulation, environmental sound classification, etc. These may be stored in a non-volatile memory for persistent use and further refinement. Alternatively or in addition, the parameter application module 924 may dynamically determine one or more values which are optimal or preferred for audio/sound or signal processing parameters based on real-time surrounding audio information, the hearing profile and the environment classification. These one or more optimal or preferred values are applied to the surrounding audio information to generate an adjusted audio/sound or signal output. Alternatively or in addition, the parameter application module 924 may also be configurable or configured to store or transmit the optimal or preferred values in a non-volatile memory or any relevant elements of the hearing aid assembly 200, 900 for use in continuous AI model training.

[00212] Once the digital signal processor 920 receives the surrounding audio, hearing profile and user's feedback, the digital signal processor 920 is configurable or configured to adjust the audio processing parameters based on the environment classifier and the hearing profile. The digital signal processor 920 then sends the hearing profile to the hearing aid transceiver assembly 210, 910 and/or one or more other elements of the system 800.

[00213] In addition to the environment classification, the digital signal processor 920 may be further configurable or configured to communicate with a hearing profile processor (e.g., hearing profile processor 1020) to generate a personalized hearing profile. The personalized hearing profile may be generated in a variety of ways. For example, the personalized hearing profile may be generated using one or more artificial intelligence (AI) models trained on user-specific data, including historical hearing preferences, environmental contexts, and feedback inputs from the user. The digital signal processor 920 may also receive one or more user feedback data which is being collected via various input modalities including pairwise comparison, preference ranking, textual input, graphical user interfaces (GUIs), spatial axis ratings, or other interactive mechanisms. The feedback may relate to the user's perception of audio quality, clarity, comfort, or intelligibility in specific environments.

[00214] The digital signal processor 920 includes a parameter application module (e.g., parameter application module 924). The parameter application module 924 is configurable or configured to adjust audio processing parameters based on the environment classifier and the hearing profile. The adjustments may be applied by the parameter application module 924 to the surrounding audio information to generate an adjusted or optimized audio or signal output for playback to the user. The parameter application module 924 may be configurable or configured to perform adjustments, optimization or modification to the audio signals (surrounding audio information) in a variety of ways. For example, the parameter application module 924 may adjust using one or more algorithms including insertion gain adjustment, compression ratio control, feedback cancellation, volume regulation, environmental sound classification, etc.. These may be stored in a non-volatile memory for persistent use and further refinement. Alternatively or in addition, the parameter application module 924 may dynamically determine one or more values which are optimal or preferred for audio/sound or signal processing parameters based on real-time surrounding audio information, the hearing profile and the environment classification. These one or more optimal or preferred values are applied to the surrounding audio information to generate an adjusted audio/sound or signal output. Alternatively or in addition, the parameter application module 924 may also be configurable or configured to store or transmit the optimal or preferred values in a non-volatile memory or any relevant elements of the hearing aid assembly 200, 900 for use in continuous AI model training.

[00215] Once the digital signal processor 920 receives the surrounding audio, hearing profile and user's feedback, the digital signal processor 920 is configurable or configured to adjust the audio processing parameters based on the environment classifier and the hearing profile. The digital signal processor 920 then sends the hearing profile to the hearing aid transceiver assembly 210, 910 and/or one or more other elements of the system 800.

[00216] The digital signal processor 920 may be configurable or configured to modify an input signal based on one or more of a variety of algorithms. Such algorithms may include insertion gain adjustment algorithm, compression ratio adjustment algorithm, feedback cancellation algorithm, volume adjustment algorithm, and/or environmental sound classification algorithm, etc.. The digital signal processor 920 may be connected to non-volatile memory (NMV) to store the audio processing parameters. The digital signal processor 920 may also be connected to a memory (e.g., non-volatile memory (NMV)) to store the hearing profile.

[00217] In one embodiment, the digital signal processor 920 is further configured to adjust received surrounding audio, as received in real-time (or near real-time or historically), to arrive at an audio output. This includes determining, via the digital signal processor 920, the surrounding audio to determine optimal values of the audio/signal processing parameters based on the hearing profile, environment classifier, the surrounding audio, etc. The optimal values of the audio/signal processing parameters may reflect the user's hearing preferences. The digital signal processor 920 may apply the determined optimal values of the audio/signal processing parameters to the received surrounding audio to arrive at the audio output for playback to the user. The digital signal processor 920 may send the determined optimal values of the audio/signal processing parameters to the hearing aid transceiver assembly 210, 910. The determined optimal values of the audio/signal processing parameters may also be stored in the memory for use in a model training process.

[00218] These elements of the digital signal processor 220 and its functions will now be further described with reference to the accompanying figures.

[00219] **The environment classifier module (e.g., environment classifier module 922).**

[00220] As illustrated in at least Figure 13, the digital signal processor 920 includes one or more environment classifier module (e.g., environment classifier module 922). Each environment classifier module 922 is configurable or configured to perform one or more of

a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The environment classifier module 922 is also configurable or configured to communicate with one or more elements of the system 800, including one or more elements of user device 10, database 30, network 40, main processor 300, 1000, communication channels (not shown), information sources (not shown), and/or resources (e.g., tools and/or applications), etc.

[00221] The environment classifier module 922 is configurable or configured to classify the environment that the user is situated (e.g., surrounding environment). The environment classifier module 922 is configurable or configured to enable the digital signal processor 920 to adapt itself to different environments for optimal sound processing. The environment classifier module 922 may be configurable or configured to identify the environment where the user is situated (e.g., noisy room, meeting room, quiet room, restaurant, school, work place, concert, beach, park, etc.). The environment classifier module 922 may adjust one or more audio/sound/signal processing parameters (e.g., insertion gain, compression ratio, feedback cancellation, volume, and/or noise reduction, etc.) to improve listening satisfaction (and/or ability to hear) based on the user's preference.

[00222] The environment classifier module 922 may include computational models to classify various environments into several categories. For example, the environment classifier module 922 may have one or more computational models to classify whether the user is in a quiet room, busy airport, open field, etc. Based on the identified environment, the environment classifier module 922 may adjust, among other things, insertion gain, compression ratio, feedback cancellation, volume, and/or noise cancellation in real-time (or near real-time). The environment classifier module 922 may be in communication with other elements of the system 800 (i.e., hearing aid transceiver assembly 210, 910, digital signal processor 920, hearing profile processor 1020, etc.) such that the environment classifier module 922 may receive trained models and/or feedback data to refine the classification for the user's preference.

[00223] **The parameter application module (e.g., parameter application module 924).**

[00224] As illustrated in at least Figure 13, the digital signal processor 920 includes one or more parameter application module (e.g., parameter application module 924). Each parameter application module 924 is configurable or configured to perform one or more of

a plurality of functions, operations, actions, methods, and/or processes including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The parameter application module 924 is also configurable or configured to communicate with one or more elements of the system 800, including one or more elements of user device 10, database 30, network 20, main processor 300, 1000, communication channels (not shown), information sources (not shown), and/or resources (e.g., tools and/or applications), etc.

[00225] The parameter application module 924 may be configurable or configured to receive an output from the environment classifier module 924 (e.g., information relating to an identified environment where the user is situated). Then, the parameter application module 924 may adjust the audio/signal processing parameters in real-time to match the identified environment. The parameter application module 924 may then be configurable or configured to update audio/sound/signal processing parameters. Alternatively or in addition, the parameter application module 924 may be adaptive such that the parameter application module 924 may be further tuned based on, for example, trained models, feedback data, the user's preference, historical usage setting, etc. Then, the parameter application module 924 is configurable or configured to send updated audio/sound/signal processing parameters to the digital signal processor 920.

[00226] **The main processor (e.g., main processor 1000).**

[00227] As illustrated in at least **FIGURE 8** and **FIGURE 10**, the system 800 for managing one or more hearing aid systems (e.g., hearing aid system 100, 800) includes one or more main processors (e.g., main processor 1000). The main processor 1000 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, managing a hearing aid system 800, receiving one or more information or details from the user device 10, and/or managing a hearing aid assembly 200, 900.

[00228] As a non-limiting example, each main processor 1000 may include one or more elements configurable or configured to perform a variety of actions, functions, operations, methods, and/or processes, including, but not limited to, managing hearing device system 800. More specifically, the main processor 1000 is configurable or configured to manage, monitor and/or control the operations of a hearing aid assembly 200, 900.

[00229] The main processor 1000 is also configurable or configured to manage, store, and/or retrieve various information from the database 30 to be used by the system 800 to manage a hearing aid assembly 200, 900 of one or more user devices 10. The main processor 1000 is configurable or configured to communicate with the one or more user information databases 30 to access, manage, store, receive, edit/change/delete, update, and/or otherwise utilize information to be used by the system 800 to manage a hearing aid assembly 200, 900 of one or more user devices 10. As described in the present disclosure, the database 30 may include information such as, but not limited to, user data, patient data, medical records, medical tests, hearing tests, hearing condition, surrounding audio information, etc.

[00230] The main processor 1000 is configurable or configured to establish one or more communication channels with the hearing aid assembly 200, 900. The main processor 1000 includes one or more audiometric profile processors 1010. The audiometric profile processor 1010 is configurable or configured to perform an example embodiment of an audiogram generation process. The main processor 1000 is also configurable or configured to establish communication between the main processor 1000 and the hearing aid assembly 200, 900 of the user. The audiogram generation process performed by the main processor 1000 includes receiving, by the main processor 1000, pure tone signals at each of a plurality of frequencies; performing an initial audiometry test for the user; and receiving initial audiometry test results for the user based on the initial audiometry test performed for the user. When the main processor 1000 receives the initial audiometry test results, the main processor 1000 is configurable or configured to perform the following: generate an audiogram for the user based on at least the initial audiometry test results; generate, based on the audiogram for the user, an initial compression ratio for the user; and generate, based on the initial compression ratio for the user, a predicted compression ratio for the user. The main processor 1000 is further configurable or configured to perform a subsequent test for the user. The subsequent test may include receiving, by the main processor 1000, surrounding audio information. Such surrounding audio information may include real-time audio-related information of a surrounding environment of the hearing aid assembly 200, 900. The main processor 1000 may be further configurable or configured to apply the generated predicted compression ratio and/or generated predicted hearing parameter for the user to the surrounding audio information. The main processor 1000 then receives, from the user, subsequent test results for the user based on the subsequent test performed for the

user. In an example embodiment, the main processor 1000 is configurable or configured to generate an optimized predicted compression ratio for the user based on the subsequent test results. Once the optimized predicted compression ratio for the user is generated, the main processor 1000 is configurable or configured to apply, to the hearing aid assembly 200, 900, the optimized predicted compression ratio for the user.

[00231] Alternatively or in addition, the main processor 1000 is also configurable or configured to continuously receive surrounding audio information in real-time, near real-time, and/or non-real-time (e.g., historic information). The surrounding audio information may include, but not limited to, a first surrounding audio obtained at a first time when the main processor 1000 performs an audiometry test based on the first surrounding audio; a second surrounding audio obtained at a second time after the first time when the main processor 1000 performs the subsequent tests based on the second surrounding audio, and/or the main processor performs the subsequent test based on the first and second surrounding audio information.

[00232] Alternatively or in addition, the main processor 1000 may also be configurable or configured to receive, collect, and/or store information, including sound-related information (e.g., surrounding, existing, historical, average/mean/etc., sound at a geolocation, location, address, landmark, area, region, etc.). The main processor 1000 may also be configurable or configured to receive, collect, and/or store other information, including historic information pertaining to adjustments proposed, suggested, and/or made by the processor and/or user. The main processor 1000 may also be configurable or configured to perform predicting, suggesting, determining, and/or adjusting of the hearing aid assembly to achieve improved hearing, including configuring the hearing aid assembly to transmit one or more optimum frequencies for the user based on, among other things, sound-related information received by the processor (e.g., surrounding, existing, historical, average/mean/etc., sound at a geolocation, location, address, landmark, area, region, etc.).

[00233] Alternatively or in addition, the main processor 1000 may be configurable or configured to perform one or more of the above actions/functions and/or one or more other actions/functions described in the present disclosure via one or more processors (e.g., a user's mobile device, a central processor, cloud computing, etc.) and/or via calculations, estimations, results, inferences, predictions, or the like, generated and/or derived, directly or indirectly, partially, in cooperation or in whole, by artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes. Such artificial intelligence (AI) algorithms,

engines, systems, processors, and/or processes may be part of the processor (also referred to herein as a main processor) and may include, but are not limited to, machine learning algorithms, deep learning algorithms, deep neural networks (DNN), recurrent neural networks (RNN), long short term memory (LSTM), convolutional neural networks (CNN), regional convolutional neural networks (R-CNN), etc. Furthermore, such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be provided locally via the processor (or main processor) and/or one or more other elements of the system (e.g., within the hearing aid assembly); and/or via one or more communication networks, cloud computing, distributed computing, and/or non-localized or decentralized artificial intelligence (AI), etc.

[00234] The audiometric profile processor (e.g., the audiometric profile processor 1010).

[00235] As illustrated in at least **FIGURE 11** and **FIGURE 12**, an example embodiment of the main processor 1000 includes one or more audiometric profile processors (e.g., audiometric profile processors 1010). The audiometric profile processor 1010 is configurable or configured to perform an example embodiment of an audiometric profile generation process. When generating an audiometric profile, the audiometric profile processor 1010 (in communication with the hearing aid assembly 200, 900; hearing aid transceiver assembly 210, 910) is configurable or configured to send a command to the hearing aid transceiver assembly 210, 910 to perform an audiometry test on the user. The hearing aid transceiver assembly 210, 910 is configurable or configured to emit audio signals to the user based on instructions received from the audiometric profile processor 1010. Such audio signals may include, but not limited to, a stimulus (e.g., a pure tone signal). The audiometric profile processor 1010 may be configurable or configured to perform one or more audiometry tests by emitting a stimulus having a frequency from between 125 to 8,000 Hz for a period of between 200 to 800 milliseconds in a plurality of batches. The audiometric profile processor 1010 may also be configurable or configured to receive an indication, from the user 10, on whether the user 10 is able to hear the stimulus in each frequency.

[00236] The audiometric profile processor 1010 is then configurable or configured to analyze a hearing condition of the user for each frequency based on the results of the audiometry test. The audiometry test, when performed by the audiometric profile processor 1010 (or the main processor 1000) may include between 2-20 batches, where each batch

may be an increase, from a previous batch, of a period of between 10-500 milliseconds followed by a period of between 10-500 milliseconds of silence. In yet another example, the audiometric profile processor 1010 may be in communication with the hearing aid transceiver assembly 210, 910 such that the audiometric profile processor 1010 may instruct the hearing aid transceiver assembly 210, 910 to emit audio signals for performing the audiometry tests.

[00237] The audiometric profile processor 1010 is further configurable or configured to receive one or more audiometry test results when an audiometry test is performed on the user. Based on the audiometry results, the audiometric profile processor 1010 is configurable or configured to generate an audiogram for the user based on the received audiometry test results for the user. The audiogram generation process, as performed by the audiometric profile processor 1010 or the main processor 1000, also further includes generating one or more initial compression ratios for the user based on the generated audiogram for the user. This also further includes generating one or more predicted compression ratios (e.g., for use with an artificial intelligence (AI) training model).

[00238] **The crossover detection module (e.g., crossover detection module 1012).**

[00239] As illustrated in at least FIGURE 12, an example embodiment of the audiometric profile processor 1010 includes one or more crossover detection modules (e.g., crossover detection module 1012). The crossover detection module 1012 is configurable or configured to manage crossovers during the audiometry test. The crossover detection module 1012 may be in communication with the hearing aid transceiver assembly 210, 910 and/or the user device 10 to enabling the user to adjust an occurrence of the crossover. The crossover detection module 1012 is configurable or configured to facilitate accurate hearing test or assessment by identifying and compensating for crossovers which occur when performing a hearing test or assessment on the user.

[00240] In an example embodiment, the crossover detection module 1012 is configurable or configured to detect, manage, correct, and/or adjust crossover events. A crossover occurs when a test pure tone signal that is intended for presentation to a target ear of the user is being perceived by the non-target ear. This results in compromised or incorrect audiometry results by misattributing auditory perception in the incorrect ear or target ear. Further, the crossover detection module 1012 receive one or more determinations from the user indicating an occurrence of a crossover during the audiometry test. For example, a crossover is deemed to have occurred when the user perceives the test pure tone signal in

the right ear when the test pure tone signal is intended to be presented the user's left ear. Similarly, when the test pure tone signal is intended to be presented the user's right ear, a crossover is deemed to have occurred the test pure tone signal is perceived in the left ear by the user.

- 5 [00241] Upon detecting or determining a crossover event, the crossover detection module 1012 is further configurable or configured to enable a user interface comprising user guided control elements to allow adjustments to spatial presentation of the test pure tone signal. The crossover detection module 1012 is configurable or configured to receive the user's input on the adjustments to the spatial presentation of the test pure tone signal. Based
10 on the user's input, the crossover detection module 1012 is configurable or configured to reposition the spatial presentation of the test pure tone signal to a midline location, which is deemed to be the central position with equivalent distant from both ears. Further, the crossover detection module 1012 is also configurable or configured to receive one or more user based input of the spatial presentation of the test pure tone signal. In response to such
15 input, the crossover detection module 1012 is configurable or configured to adjust one or more hearing thresholds of the user based on the input of the spatial presentation of the test pure tone signal from the user. Such adjustments are made to reflect the corrected perception of the test pure tone signal and enhancing the accuracy of the audiometry test results. Alternatively or in addition, the crossover detection module 1012 may be
20 configurable or configured to generate a corrected audiometric data which represents a more accurate audiometric profile for the user by using the corrected hearing thresholds.

[00242] **The threshold determination module (e.g., threshold determination module 1014.**

- [00243] As illustrated in at least **FIGURE 12**, an example embodiment of the audiometric profile processor 1010 includes one or more threshold determination modules (e.g.,
25 threshold determination module 1014). The threshold determination module 1014 is configurable or configured to determine one or more hearing or auditory thresholds for a user based on the audiometry test results obtained from the audiometry test or audiometric testing or assessment.

- 30 [00244] In an example embodiment, the threshold determination module 1014 is configurable or configured to receive the audiometry test results obtained from the audiometry test or audiometric testing or assessment. Upon receiving the audiometry test results, the threshold determination module 1014 is configurable or configured to process

and analyze the responses by the user to identify the minimum level of intensity at which the user can perceive or hear the test pure tone signal at varying frequencies and/or intensities. The responses by the user are captured when the user is presented or prompted with a test pure tone signal and the user identifies or indicates that the signal is perceived or heard. This identification or indication may be provided by the user through manual interaction such as, but not limited to, pressing a button or selecting a response on user interface. Alternatively or in addition, the threshold determination module 1014 may determine the hearing thresholds to be stored as part of the user's audiometric profile and/or may be used to generate an audiogram.

10 **[00245] The response time module (e.g., response time module 1016)**

[00246] As illustrated in at least **FIGURE 12**, an example embodiment of the audiometric profile processor 1010 includes one or more response time modules (e.g., response time module 1016). The response time module 1016 is configurable or configured to determine the time between the presentation of an auditory stimulus (e.g., test pure tone signal) and the corresponding response to the stimulus from the user.

[00247] In an example embodiment, the response time module 1016 is configurable or configured to determine or monitor the responses from the user during the audiometry test. The response time module 1014 is able to capture or determine the latency between the presentation of the test pure tone signal and the user's corresponding response. The latency, which may be referred to as response time, is an indicative of the user's perception, auditory processing speed, etc. The response time module 1016 is also able to record and/or store response latency across multiple frequencies and intensity levels. The response time module 1016 is configurable or configured to operate together with the threshold determination module 1016 and/or other elements of the audiometric profile processor 1010 to enhance the accuracy, reliability, and diagnostic values of the audiometric profile. Alternatively or in addition, the response time module 1016 may also be configurable or configured to determine whether a crossover has occurred.

25 **[00248] The audiometric profile generator (e.g., audiometric profile generator 1018)**

[00249] As illustrated in at least **FIGURE 10**, an example embodiment of the audiometric profile processor 1010 includes one or more audiometric profile generator (e.g., threshold determination module 1018). The audiometric profile generator 1018 is configurable or configured to generate an audiometric profile for a user.

[00250] In an example embodiment, the audiometric profile generator 1018 may receive one or more data or information from the crossover detection module 1012, the threshold determination module 1014, and/or the response time module 1016. The audiometric profile generator 1018 may receive one or more crossover detection data from the crossover detection module 1012 to generate the audiometric profile. As described, the data by the crossover detection module 1012 may include determination of instances where an audio stimulus (e.g., pure tone signal) is presented to a target ear but is perceived by the non-target ear, indicating a crossover event. The audiometric profile generator 1018 may also configurable or configured to generate the audiometric profile based on the spatial presentation adjustments and user-guided corrections from the crossover detection module 1012. The audiometric profile generator 1018 may receive one or more hearing threshold data of the user from the threshold determination module 1014 to generate the audiometric profile. As described, the data by the threshold determination module 1014 may include frequency-specific thresholds for each ear which are determined by identifying or determining the minimum intensity level at which the user is able to perceive or hear the audio stimulus (e.g., pure tone signal). The audiometric profile generator 1018 may receive one or more response time data from the response time module 1016. As described, the data by the response time module 1016 may include time interval between the time between the presentation of an auditory stimulus (e.g., test pure tone signal) and the corresponding response to the stimulus from the user. The audiometric profile generator 1018 may also configurable or configured to generate the audiometric profile based on data or information including auditory processing speed, response consistency, and perceptual certainty.

[00251] Further, the audiometric profile generator 1018 is configurable or configured to generate an audiometric profile that may be used or utilized to construct or generate a hearing profile, as will be described further in the present disclosure.

[00252] **The hearing profile processor (e.g., hearing profile processor 1020).**

[00253] As illustrated in at least **FIGURE 13**, an example embodiment of the main processor 1000 includes one or more hearing profile processor (e.g., hearing profile processor 1020). Each hearing profile processor 1020 is configurable or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The hearing profile processor 1020 is also configurable or configured to communicate with one or more

elements of the system 800, including one or more microphones, one or more user devices 10, one or more databases 30, one or more hearing aid transceiver assemblies 210, 910, one or more digital signal processors 920, and/or one or more communication channels (not shown).

5 [00254] In an example embodiment, the hearing profile processor 1020 is configurable or configured to receive an audiometric profile from the audiometric profile processor 1010 or the audiometric profile generator 1018. The hearing profile processor 1020 is configurable or configured to process the received audiometric profile to generate a comprehensive hearing profile for the user. Further, the hearing profile processor 1020 is configurable or configured to include one or more parameter analyzer module (e.g., parameter analyzer module 1022) and/or one or more parameter optimization module (e.g., parameter analyzer module 1024), which will be further described in the present disclosure.

[00255] **The parameter analyzer module (e.g., parameter analyzer module 1022).**

[00256] As illustrated in at least FIGURE 13, an example embodiment of the hearing profile processor 1020 includes one or more parameter analyzer module (e.g., parameter analyzer module 1022). The parameter analyzer module 1022 is configurable or configured to extract, evaluate, process, analyze and/or classify hearing parameters from the audiometric profile. These hearing parameters may include, but are not limited to, compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters, frequency-specific hearing thresholds, response time, crossover correction data, spatial perception, etc.. The parameter analyzer module 1022 may also be configurable or configured to apply rule-based logic, statistical models, or machine learning algorithms to assess the significance and reliability of each parameter. For example, the parameter analyzer module 1022 may identify one or more threshold patterns which may indicate sensorineural hearing loss, detect delayed response times suggestive of auditory processing deficits, or flag inconsistencies in spatial perception that may require retesting.

[00257] **The parameter optimization module (e.g., parameter optimization module 1024)**

30 [00258] As illustrated in at least FIGURE 13, an example embodiment of the hearing profile processor 1020 includes one or more parameter optimization module (e.g., parameter optimization module 1024). The parameter optimization module 1024 is configurable or configured to optimize, refine and calibrate the hearing parameters from the audiometric

profile. These hearing parameters may include, but are not limited to, compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters, frequency-specific hearing thresholds, response time, crossover correction data, spatial perception, etc. Upon receiving analyzed data from the parameter analyzer module

5 1022, the parameter optimization module 1024 applies optimization algorithms to enhance the precision, consistency, and clinical relevance of each parameter. The parameter optimization module 1024 may also incorporate other data during optimization such as environmental conditions or historical audiometric records to further refine the output.

[00259] The hearing profile generator (e.g., hearing profile generator 1026)

10 **[00260]** As illustrated in at least **FIGURE 13**, an example embodiment of the hearing profile processor 1020 includes one or more hearing profile generator (e.g., hearing profile generator 1026). The hearing profile generator 1026 is configurable or configured to generate a hearing profile for a user.

15 **[00261]** In an example embodiment, the hearing profile processor 1020 is further configurable or configured to perform a hearing profile optimization process. The hearing profile optimization process may include receiving, from the hearing aid transceiver assembly, the surrounding audio information. The hearing profile optimization process may also include performing a subsequent test for the user, the subsequent test including

20 applying the generated hearing profile for the user to the received surrounding audio information. The hearing profile optimization process may also include receiving, from the user, one or more subsequent test results based on the subsequent test for the user. The hearing profile optimization process may also include generating, an optimized hearing profile for the user based on the subsequent test results. The hearing profile optimization

25 process may also include storing, the optimized hearing profile for the user in the hearing profile processor.

[00262] During the subsequent test, the hearing profile processor 1020 is further configured to receive one or more feedback by the user for the one or more received surrounding audio information. The user can provide one or more feedbacks for the one or

30 more received surrounding audio information in various methods, including but not limited to pairwise comparison, textual input, spatial axis rating, preferred audio rating, preference ranking, text input with LLM adjustment, etc.. These methods can be used individually or in combination. For example, the pairwise comparison method can be performed

individually, or the pairwise comparison method can be performed alongside the spatial axis rating method. The hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. The one or more trained AI models may be used for predicting one or more audio processing parameters of the surrounding audio information.

[00263] In an example embodiment, during the subsequent test, one or more feedbacks by the user for the one or more received surrounding audio information may be provided. The feedback maybe in the form of pairwise comparison. In this regard, the hearing profile processor 1020 may further include a pairwise comparison assessor (not shown). The pairwise comparison assessor (not shown) is configured to process the pairwise comparison assessor to arrive at one or more feedback data.

[00264] The pairwise comparison assessor (not shown) is also configured or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40, hearing aid transceiver assembly 910, audiometric profile processor 1010, hearing profile processor 1020, parameter optimization processor 1030, other pairwise comparison assessor (not shown), textual input assessor (not shown), spatial axis rating assessor (not shown), and preference ranking (not shown).

[00265] When the user provides the feedback in the form of pairwise comparison, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback through the pairwise comparison method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

[00266] For example, when the user provides the feedback in the form of pairwise comparison, the pairwise comparison assessor (not shown) is configurable or configured to display for the user in order to start comparing preferred audio. Preferred audio can be selected by pressing one of several buttons (e.g., 4 buttons such as "Audio A", "Audio B", "Audio A and B", and " Audio A and B not preferred", where Audio A refers to sound that the a first generated hearing profile applied to the received surrounding audio, and Audio B

refers to sound that a second generated hearing profile applied to the received surrounding audio).

[00267] In an example embodiment, during the subsequent test, one or more feedbacks by the user for the one or more received surrounding audio information may be provided. The feedback maybe in the form of textual input. In this regard, the hearing profile processor 1020 may further include a textual input assessor (not shown). The textual input assessor (not shown) may be configurable or configured to process the textual input to arrive at one or more feedback data. The textual input assessor (not shown) is configured to process the textual input to arrive at one or more feedback data. The processing of the textual input includes: receiving the textual input on the received surrounding audio information by the user from the hearing aid transceiver assembly; assessing the textual input to predict a weighing factor for each of the textual input for each received surrounding audio information, the weighing factor predicted based on the one or more feedback data; and storing the feedback data for each generated hearing profile and the received surrounding audio information to the hearing profile processor.

[00268] The textual input assessor (not shown) is also configured or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40, hearing aid transceiver assembly 910, audiometric profile processor 1010, hearing profile processor 1020, parameter optimization processor 1030, pairwise comparison assessor (not shown), other textual input assessor (not shown), spatial axis rating assessor (not shown), and preference ranking (not shown).

[00269] When the user provides the feedback in the form of text input, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback through the text input method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

[00270] For example, when the user provides the feedback in the form of textual input, the user is requested to provide textual feedback of a sound. The textual feedback is

processed by using a Large Language Model (LLM) by capturing the word context and predict the weighing factor of importance for each set of compression ratios.

[00271] In an example embodiment, during the subsequent test, one or more feedbacks by the user for the one or more received surrounding audio information may be provided. The feedback maybe in the form of ratings. The ratings are spatial axis ratings. In this regard, the hearing profile processor 1020 may further include a spatial axis rating assessor (not shown). The spatial axis rating assessor (not shown) is configured to process the spatial axis rating to arrive at one or more feedback data. The spatial axis rating assessor (not shown) may be configurable or configured to process subjective feedback to arrive at one or more feedback data, the processing includes: receiving the subjective feedback on the received surrounding audio information by the user from the hearing aid transceiver assembly 910; responsive to a determination, by the user, a subjective feedback of the received surrounding audio information: plotting the subjective feedback including a soft, loud, muffled, clear, etc. audio; determining a discount coefficient based on the subjective feedback plotted on the spatial axis for each received surrounding audio information, the discount coefficient is the one or more feedback data; and storing the feedback data for each generated hearing profile and the received surrounding audio information in the hearing profile processor.

[00272] The spatial axis rating assessor (not shown) is also configured or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40, hearing aid transceiver assembly 910, audiometric profile processor 1010, hearing profile processor 1020, parameter optimization processor 1030, pairwise comparison assessor (not shown), textual input assessor (not shown), other spatial axis rating assessor (not shown), and preference ranking (not shown).

[00273] When the user provides the feedback in the form of spatial axis rating, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback through the spatial axis rating method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the

generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

[00274] For example, when the user provides the feedback in the form of spatial axis rating, the user is prompted to provide feedback of a sound by plotting the subjective
5 feedback including soft, loud, muffled, clear, etc. to determine a discount coefficient to predict an adjusted compression ratio and/or hearing parameters.

[00275] In an example embodiment, during the subsequent test, one or more
feedbacks by the user for the one or more received surrounding audio information may be provided. The feedback maybe in the form of ranking. The ranking is a preference ranking.
10 In this regard, the hearing profile processor 1020 may further include preference ranking assessor (not shown). The preference ranking assessor (not shown) is configured to process the preference ranking to arrive at one or more feedback data. The preference ranking assessor may be configurable or configured to process one or more preferences by the user on the received surrounding audio information at one or more feedback data. The
15 processing includes: receiving the one or more preferences on the received surrounding audio information by the user from the hearing aid transceiver assembly 910; responsive to a determination on the preference for each received surrounding audio information: assigning a rating to each of the received surrounding audio information based on the preference determined by the user; and storing the feedback data for each generated hearing
20 profile and the received surrounding audio information in the hearing profile processor.

[00276] The preference ranking assessor (not shown) is also configured or configured to communicate and/or connect with main processor 300, user device 10, hearing aid assembly 200, database 30, network 40, hearing aid transceiver assembly 910, audiometric profile processor 1010, hearing profile processor 1020, parameter optimization processor
25 1030, pairwise comparison assessor (not shown), textual input assessor (not shown), spatial axis rating assessor (not shown), and other preference ranking (not shown).

[00277] When the user provides the feedback in the form of preference ranking, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the
30 hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback through the preference ranking method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may

generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

[00278] Alternatively or in addition, The feedback maybe in the form of text input
5 with LLM adjustment. When the user provides the feedback in the form of text input with LLM adjustment, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback
10 prompts and scores through the text input with LLM adjustment method. Based on the provided feedback, the LLM may process the feedback and generate the hearing profile. The LLM may store prompts and scores in the database. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

15 [00279] **The parameter optimization processor (e.g., parameter optimization processor 1030).**

[00280] As illustrated in at least **FIGURE 11**, an example embodiment of the main processor 1000 includes one or more parameter optimization processor (e.g., parameter optimization processor 1030). Each parameter optimization processor 1030 is configurable
20 or configured to perform one or more of a plurality of functions, operations, actions, methods, and/or processes, including, but not limited to, receive, process, and/or manage requests and/or commands received from one or more elements of the system 800. The parameter optimization processor 1030 is also configurable or configured to communicate with one or more elements of the system 800, including one or more microphones, one or
25 more user devices 10, one or more databases 30, one or more hearing aid transceiver assemblies 210, 910, one or more digital signal processors 920, and/or one or more communication channels (not shown). Furthermore, parameter optimization processor 1030 is configurable or configured to receive, request, retrieve, and/or obtain information from one or more information sources (e.g., databases and networks) and/or resources (e.g., tools
30 and/or applications).

[00281] In an example embodiment, the parameter optimization processor 1030 is configurable or configured to further adjust one or more hearing parameters for audio processing. By doing so, the parameter optimization processor 1030 may be configurable

or configured to receive a hearing profile from the audiometric profile processor 1010. The parameter optimization processor 1030 may be configurable or configured to optimize the hearing parameters to match the user's hearing profile (e.g., type and degree, or severity of the hearing loss). The parameter optimization processor 1030 may send the optimized hearing parameters to the digital signal processor 920 or one or more elements of the system 800. For example, the optimized hearing profile may be generated using one or more artificial intelligence (AI) models trained on user-specific data, including historical hearing preferences, environmental contexts, and feedback inputs from the user. The digital signal processor 920 may also receive one or more user feedback data which is being collected via various input modalities including pairwise comparison, preference ranking, textual input, graphical user interfaces (GUIs), spatial axis ratings, or other interactive mechanisms. The feedback may relate to the user's perception of audio quality, clarity, comfort, or intelligibility in specific environments.

[00282] Alternatively or in addition, when one or more elements of the hearing aid system 800 have been trained using AI, the parameter optimization processor 1030 may also be configurable or configured to receive other information (i.e., not limited to the hearing profile) from one or more elements of the system 800. That is, the parameter optimization processor 1030 may further receive real-time surrounding audio-related information from the hearing aid transceiver assembly 210, 910. The parameter optimization processor 1030 may continuously learn from the historical user data received from one or more elements of the system 800 by using AI-trained models to the received information. The received information and/or historical user data may include, for example, surrounding audio information in different environments, feedback data provided by the user, response time, settings, user's preference, hearing profile, other hearing parameters, etc.. The parameter optimization processor 1030 may use the received information to continuously optimize hearing parameters over time. The parameter optimization processor 1030 may also adapt and improve hearing parameters through ongoing learning.

[00283] As an example, when the hearing aid system 800 is in an active mode, the parameter optimization processor 1030 may receive a hearing profile from the hearing profile processor 1020, in which the hearing profile may indicate that the user has difficulty in perceiving high-pitched sound. The parameter optimization processor 1030 may also be in communication with the hearing aid transceiver assembly 210, 910 and/or one or more elements of the system 800 to receive real-time surrounding audio-related information, in

which the hearing aid transceiver assembly 210, 910 may detect that the user is in a busy airport. In response, the parameter optimization processor 1030 may be configurable or configured to optimize the hearing parameters such as compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters to match the user's hearing profile. Then, the parameter optimization processor 1030 may further adjust the hearing parameters, for example, the parameter optimization processor 1030 may activate background noise suppression and boost mid-to-high frequencies to help to user hear the airport announcements or conversations in crowded zones. It should be noted that the parameter optimization processor 1030 may optimize the hearing profile either before, after, or concurrently with the optimization of hearing parameters based on the real-time environment. Alternatively or in addition, the parameter optimization processor 1030 may also recognize the airport is the current environment and associate the airport with a specific set of optimized hearing parameters, so that the parameter optimization processor 1030 learns to apply the specific set of optimized hearing parameters dynamically next time when the hearing aid transceiver assembly 210, 910 detects the user is in the airport. The optimized hearing parameters may then be applied to the hearing aid transceiver assembly 210, 910 before being emitted to the user. This allows the hearing aid system 800 to send the audio output to the user based on real-time environment with more personalized experience.

[00284] Although the figures may illustrate one main hearing aid transceiver assembly 210, 910, one audiometric profile processor 1010, one digital signal processor 920, one hearing profile processor 1020, one parameter optimization processor 1030, one crossover detection module 1012, one threshold extraction module 1014, one response time module 1016, one environmental classifier module 922, and one parameter application module 924, it is to be understood that the hearing aid assembly 200, 900 and/or system 800 may include more or less than one hearing aid transceiver assembly 210, more or less than one audiometric processor 320, more or less than one main hearing aid transceiver assembly 210, 910, more or less than one audiometric profile processor 1010, more or less than one digital signal processor 920, more or less than one hearing profile processor 1020, more or less than one parameter optimization processor 1030, more or less than one crossover detection module 1012, more or less than one threshold extraction module 1014, more or less than one response time module 1016, more or less than one environmental classifier module 922, and/or more or less than one parameter application module 924 without

departing from the teachings of the present disclosure. It is also to be understood in the present disclosure that, although the actions, functions, processes, and/or methods performed by the main processor 1000 may be described in the present disclosure as being performed by one or more particular elements of the main processor 1000, the actions, functions, processes, and/or methods performed by a particular element of the main processor 1000 may also be performed by one or more other elements and/or cooperatively performed by more than one element of the main processor 1000 (and/or other elements of the system 800) without departing from the teachings of the present disclosure. It is also to be understood in the present disclosure that, although the actions, functions, processes, and/or methods performed by the main processor 1000 are described in the present disclosure as being performed by particular elements of the main processor 1000, the actions, functions, processes, and/or methods performed by two or more particular elements of the main processor 1000 may be combined and performed by one element of the main processor 300 without departing from the teachings of the present disclosure.

[00285] In an example embodiment, the main processor 1000 performs the above actions/functions and/or other actions/functions described in the present disclosure, via one or more processors of the main processor 1000 and/or via calculations, estimations, results, inferences, predictions, or the like, generated and/or derived, directly or indirectly, partially, in cooperation or in whole, by artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes. Such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be part of the main processor 1000 and/or the system 800 and may include, but are not limited to, machine learning algorithms, long short term memory (LSTM), reinforce learning technique, etc. Furthermore, such artificial intelligence (AI) algorithms, engines, systems, processors, and/or processes may be provided locally via the main processor 1000 (and/or one or more other elements of the system 800) and/or via network 40, cloud computing 40, distributed computing 40, and/or non-localized or decentralized artificial intelligence (AI) 40, and others.

[00286] **Example embodiments of a method for managing a hearing aid (e.g., method 1100).**

[00287] As illustrated in at least **FIGURE 14**, an example of a second embodiments of a method (e.g., method 1100) for managing a hearing aid assembly is disclosed. The method 1100 may include more elements/components and/or processes, including an audiometric profile generation process 1120, a hearing profile generation process 1130, a

surrounding audio adjustment process 1140, and a crossover management process (not shown).

[00288] To perform the actions, functions, processes, and/or methods described above and in the present disclosure, example embodiments of the method 1100 include one or more steps.

[00289] In the second embodiment, the method 1100 for managing a hearing aid device includes establishing a communication channel between an example embodiment of a main processor and an example embodiment of a hearing aid assembly of the user (e.g., action 1110). The communication channel may be or include a wireless communication channel such as those implemented via Bluetooth, Wi-fi, Global Positioning System (GPS), or Wireless Local Area Network (Wireless LAN) technologies. The audiometric profile generation process (e.g., action 1120) may be performed by an example embodiment of a audiometric profile processor. The audiometric profile generation process (e.g., action 1120) includes sending, by the main processor, a command to perform an audiometry test on the user. The audiometry test may include pure tone audiometry, speech audiometry, speech-in-noise test, and/or noise-masked pure tone audiometry. The audiometry test includes an example embodiment of the hearing aid transceiver 910 assembly emitting pure tone signals to the user. The method also includes receiving, from an example embodiment of the hearing aid transceiver assembly 910, audiometry test results. The audiometry test results includes a hearing threshold of the user based on the audiometry test performed on the user. The method also includes generating an audiometric profile for the user based on the received hearing threshold of the user. The method also includes sending the audiometric profile to an example embodiment of a hearing profile processor.

[00290] Further, in the present disclosure, the method for the audiometric profile generation process (e.g., action 1120) further includes collecting information on the audio signals generated during the audiometry test, including frequencies, intensities, thresholds, and/or duration. The method also includes collecting information on responses from the user, including response time, response accuracy, and/or response latency. The method also includes processing the collected information on the audio signals and the responses for the audiometry profile processor to generate an audiogram. The audiogram is part of the audiometric profile.

[00291] In regards to example embodiments of the audiometric profile generation process (e.g., action 1120) the method also includes emitting (or transmitting) pure tone

signals having a frequency from between 125 to 8,000 Hz for a period of between 200 to 800 milliseconds in a plurality of batches. For example, the method may perform between 2-20 batches, in which each batch may include an increase (as compared to a previous batch) for a period of between 10-500 milliseconds followed by a period of between 10-500 milliseconds of silence. The method may also include receiving, from the user, one or more determination on whether the user is able to hear the audio signal in each frequency. The method also includes analyzing a hearing condition of the user for each frequency based on the results of the audiometry test.

[00292] When the pure tone audiometry is completed, the processor is configurable or configured to display for the user in order to start rating preferred audio. Preferred audio can be rated by pressing one of several buttons (e.g., 4 buttons such as "Audio A", "Audio B", "Audio A and B", and "Audio A and B not preferred")

[00293] When the rating of preferred audio is complete, the processor is configurable or configured to prompt the user to start the feedback session. The feedback of the sound can be performed by several methods, including textual input and spatial axis ratings. When the user select textual input, the user is requested to provide textual feedback of a sound. The textual feedback is processed by using a Large Language Model (LLM) by capturing the word context and predict the weighing factor of importance for each set of compression ratios. On the other hand, when the user select spatial axis ratings, the user is prompted to provide feedback of a sound by plotting the subjective feedback including soft, loud, muffled, clear, etc. to determine a discount coefficient to predict an adjusted compression ratio and/or hearing parameters. Both types of feedbacks are stored.

[00294] The present disclosure also includes more elements/components and/or processes of the crossover management process. The crossover management process. The crossover management process may be performed by an example embodiment of an audiometric profile processor. That is, the method includes receiving one or more determination from the user indicating an occurrence of a crossover. The crossover occurs when a test pure tone signal presented to a target ear is perceived by a non-target ear. The method also includes responsive to a determination, by the user, a test pure tone signal presented to a target ear is perceived by a non-target ear. This may include enabling a user interface having user guided control elements configured to allow adjustments to spatial presentation of the test pure tone signal; receiving, from the user, an input on the adjustments to the spatial presentation; and repositioning the spatial presentation of the test pure tone

signal to a midline location. The method further includes performing the crossover management process using a correction module configured to receive one or more user based input of the spatial presentation of the test pure tone signal from the user. The correction module is also configurable or configured to adjust the hearing thresholds of the user based on the input of the spatial presentation of the test pure tone signal from the user. The adjustments resulting in a corrected audiometry test results. The crossover during the audiometry test are managed in real-time or almost real-time.

[00295] In another example embodiment, the method 1100 may incorporate additional hearing parameters, not limited to the compression ratio for generating the hearing profile. The method 1100 may include additional elements/components and/or processes of the hearing profile generation process (e.g., action 1130). That is, the method 1100 includes performing, by an example embodiment of a main processor via the communication channel, a hearing profile generation process (e.g., action 1130). The hearing profile generation process (e.g., action 1130) may be performed by an example embodiment of a hearing profile processor. The hearing profile generation process (e.g., action 1130) includes receiving, from an example embodiment of a audiometric profile processor, the audiometric profile. The hearing profile generation process (e.g., action 1130) also includes generating, based on the received audiometric profile, a hearing profile for the user. The hearing profile has at least one hearing parameter for audio processing. The hearing profile includes at least one or more hearing parameters for audio processing. The hearing profile generation process (e.g., action 1130) includes performing a hearing profile optimization process to generate an optimized hearing profile. Then, the hearing profile generation process (e.g., action 1130) includes instructing an example embodiment of a hearing aid assembly to perform an example embodiment of a surrounding audio adjustment process (e.g., action 1140) based on the optimized hearing profile by sending the optimized hearing profile to an example embodiment of a hearing aid transceiver assembly 910 and instructing the hearing aid transceiver assembly 910 to perform the surrounding audio adjustment process (e.g., action 1140).

[00296] Further, in the present disclosure, when generating the hearing profile, the method also includes determining at least one of the following parameters including compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters. The method further includes storing the compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal

processing parameters for artificial intelligence (AI) model training. The artificial intelligence (AI) is used when generating the hearing profile for the user. The method further includes determining a value or each of the compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters. The determination is based on one or more characteristics of the surrounding audio received by an example embodiment of a hearing aid assembly and the audiometric profile.

[00297] In another example embodiment, the method 1100 may include a hearing profile optimization process (not shown). The hearing profile optimization process may include receiving, from the hearing aid transceiver assembly 910, the surrounding audio information. The hearing profile optimization process may also include performing a subsequent test for the user, the subsequent test including applying the generated hearing profile for the user to the received surrounding audio information. The hearing profile optimization process may also include receiving, from the user, one or more subsequent test results based on the subsequent test for the user. The hearing profile optimization process may also include generating, an optimized hearing profile for the user based on the subsequent test results. The hearing profile optimization process (e.g., action 1130) may also include storing, the optimized hearing profile for the user in the hearing profile processor.

[00298] During the subsequent test, the hearing profile processor 1020 is further configured to receive one or more feedback by the user for the one or more received surrounding audio information. The user can provide one or more feedbacks for the one or more received surrounding audio information in various methods, including but not limited to pairwise comparison, textual input, spatial axis rating, preferred audio rating, preference ranking, text input with LLM adjustment, etc.. These methods can be used individually or in combination. For example, the pairwise comparison method can be performed individually, or the pairwise comparison method can be performed alongside the spatial axis rating method. The hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. The one or more trained AI models may be used for predicting one or more audio processing parameters of the surrounding audio information.

[00299] When the user provides the feedback in the form of pairwise comparison, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the

hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback through the pairwise comparison method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor
5 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

[00300] For example, when the user provides the feedback in the form of pairwise comparison, the pairwise comparison assessor (not shown) is configurable or configured to
10 display for the user in order to start comparing preferred audio. Preferred audio can be selected by pressing one of several buttons (e.g., 4 buttons such as "Audio A", "Audio B", "Audio A and B", and "Audio A and B not preferred", where Audio A refers to sound that the a first generated hearing profile applied to the received surrounding audio, and Audio B refers to sound that a second generated hearing profile applied to the received surrounding
15 audio).

[00301] When the user provides the feedback in the form of text input, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio
20 to the user. The user may be required to provide feedback through the text input method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and
25 emits the surrounding audio to the user.

[00302] For example, when the user provides the feedback in the form of textual input, the user is requested to provide textual feedback of a sound. The textual feedback is processed by using a Large Language Model (LLM) by capturing the word context and predict the weighing factor of importance for each set of compression ratios.

30 **[00303]** When the user provides the feedback in the form of spatial axis rating, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the

surrounding audio to the user. The user may be required to provide feedback through the spatial axis rating method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

5 [00304] For example, when the user provides the feedback in the form of spatial axis rating, the user is prompted to provide feedback of a sound by plotting the subjective feedback including soft, loud, muffled, clear, etc. to determine a discount coefficient to predict an adjusted compression ratio and/or hearing parameters.

10 [00305] When the user provides the feedback in the form of preference ranking, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback through the preference ranking method. The hearing profile processor 1020 may also store the feedback in the database. Based on the provided feedback, the hearing profile processor 1020 may generate the hearing profile to the user. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

15 [00306] When the user provides the feedback in the form of text input with LLM adjustment, the hearing profile processor 1020 may collect the one or more feedbacks for use in training one or more AI models. Processes to collect the feedback may include, for example the hearing aid transceiver assembly 910 receives the surrounding audio and emits the surrounding audio to the user. The user may be required to provide feedback prompts and scores through the text input with LLM adjustment method. Based on the provided feedback, the LLM may process the feedback and generate the hearing profile. The LLM may store prompts and scores in the database. Then, the process loop is repeated, where the generated hearing profile may be sent to the hearing aid transceiver assembly 910, which receives the surrounding audio and emits the surrounding audio to the user.

20 [00307] In the present disclosure, the method also includes continuously receiving feedback data on one or more surrounding audio to perform an artificial intelligence (AI) model training to arrive at a trained artificial intelligence (AI) model for generating the

optimal values of the audio/signal processing parameters. During the process of receiving feedback data to perform an artificial intelligence (AI) model training, the user listens to the surrounding audio that has been adjusted by the main processor 300. The user is required to provide the feedback data based on the surrounding audio to an example embodiment of
5 a hearing aid transceiver assembly 910.

[00308] In an example embodiment, the responses from the user may include one or more textual inputs from the user. For example, the user may provide textual inputs describing the audio generated such as typing the word "loud" when the user hears loud (or high volume) generated sound. In an example embodiment, the textual inputs are provided
10 as input to a model (e.g., a large language model (LLM), which may be configured to capture a word context and predict a weighing factor of each set of the audio sound).

[00309] The method 1100 may also include additional elements/components and/or processes of the surrounding audio adjustment process (e.g., action 1140) as illustrated at least in **FIGURE 15**. That is, after sending the hearing profile to an example embodiment
15 of a hearing aid transceiver assembly 910, the method 1140 includes performing, by the processor via the communication channel, an example embodiment of a surrounding audio adjustment process (e.g., action 1140). The surrounding audio adjustment process (e.g., action 1140) may be performed by an example embodiment of a digital signal processor 920. The surrounding audio adjustment process (e.g., action 1140) includes receiving, from
20 an example embodiment of a hearing aid transceiver assembly 910, the surrounding audio (e.g., action 1142). The surrounding audio adjustment process (e.g., action 1140) also includes determining, based on the surrounding audio, an environment classifier 1144. The surrounding audio adjustment process (e.g., action 1140) also includes generating an adjusted audio output for the user by adjusting, based on the environment classifier and the
25 hearing profile, one or more audio processing parameters of the surrounding audio information (e.g., action 1146)

[00310] In regards to example embodiments of receiving surrounding audio information (e.g., action 1142), the information on surrounding audio may be a real-time audio information of a surrounding environment. The surrounding audio information may
30 also include, but is not limited to, at least one of the following information: date, time, pressure, humidity, geolocation, pressure, etc. In the example embodiment, the surrounding audio information may be obtained, collected, received, or the like, from the hearing aid assembly of the user and/or the processor. The surrounding audio information may be

received from, for examples, but not limited to, Global Positioning System (GPS) on iOS or Android operating system, or a sound capturing element such as a microphone and/or sensor installed in an example embodiment of a hearing aid assembly.

[00311] Further, in the present disclosure, when performing the surrounding audio adjustment process (e.g., action 1140), the method also includes adjusting the surrounding audio, as received in real-time, into the audio output. The adjusting the surrounding audio process includes determining, via a signal processing module, the surrounding audio to determine optimal values of the audio/signal processing parameters based on the hearing profile, environment classifier, and/or the surrounding audio. The method also includes applying, via the signal processing module. The determined optimal values of the audio/signal processing parameters to the surrounding audio to arrive at the audio output for playback to the user.

[00312] Various terms used herein have special meanings within the present technical field. Whether a particular term should be construed as such a "term of art" depends on the context in which that term is used. Such terms are to be construed in light of the context in which they are used in the present disclosure and as one of ordinary skill in the art would understand those terms in the disclosed context. The above definitions are not exclusive of other meanings that might be imparted to those terms based on the disclosed context.

[00313] Words of comparison, measurement, and timing such as "at the time," "equivalent," "during," "complete," and the like should be understood to mean "substantially at the time," "substantially equivalent," "substantially during," "substantially complete," etc., where "substantially" means that such comparisons, measurements, and timings are practicable to accomplish the implicitly or expressly stated desired result.

[00314] While various embodiments in accordance with the disclosed principles have been described above, it should be understood that they have been presented by way of example only, and are not limiting. Thus, the breadth and scope of the example embodiments described in the present disclosure should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the claims and their equivalents issuing from this disclosure. Furthermore, the above advantages and features are provided in described embodiments, but shall not limit the application of such issued claims to processes and structures accomplishing any or all of the above advantages.

[00315] For example, "communication," "communicate," "connection," "connect," or other similar terms should generally be construed broadly to mean a wired, wireless, and/or other form of, as applicable, connection between elements, devices, computing devices, telephones, processors, controllers, servers, networks, telephone networks, the cloud, and/or
5 the like, which enable voice and/or data to be sent, transmitted, broadcasted, received, intercepted, acquired, and/or transferred (each as applicable). Furthermore, words such as "sound", "acoustic", and "audio" are intended to have similar or the same meaning in the present disclosure, and as such may be used interchangeably and/or in place of each other.

[00316] Various terms used herein have special meanings within the present technical
10 field. Whether a particular term should be construed as such a "term of art" depends on the context in which that term is used. Such terms are to be construed in light of the context in which they are used in the present disclosure and as one of ordinary skill in the art would understand those terms in the disclosed context. The above definitions are not exclusive of other meanings that might be imparted to those terms based on the disclosed context.

[00317] Additionally, the section headings and topic headings herein are provided for consistency with the suggestions under various patent regulations and practice, or otherwise to provide organizational cues. These headings shall not limit or characterize the
15 embodiments set out in any claims that may issue from this disclosure. Specifically, a description of a technology in the "Background" is not to be construed as an admission that technology is prior art to any embodiments in this disclosure. Furthermore, any reference
20 in this disclosure to "invention" in the singular should not be used to argue that there is only a single point of novelty in this disclosure. Multiple inventions may be set forth according to the limitations of the claims issuing from this disclosure, and such claims accordingly define the invention(s), and their equivalents, that are protected thereby. In all instances,
25 the scope of such claims shall be considered on their own merits in light of this disclosure, but should not be constrained by the headings herein.

Claims

1. A hearing aid system, the hearing aid system comprising:
 - a hearing aid assembly, the hearing aid assembly configured to be securable to a user, the hearing aid assembly including:
 - 5 a hearing aid transceiver assembly, the hearing aid transceiver assembly configured to:
 - selectively emit audio signals to the user based on instructions received from a main processor; and
 - obtain surrounding audio information, the surrounding audio
 - 10 information including real-time surrounding audio-related information of a surrounding environment of the hearing aid assembly;
 - the main processor, the main processor in communication with the hearing aid assembly, the main processor including:
 - an audiometric processor, the audiometric processor configured to perform
 - 15 an audiogram generation process, the audiogram generation process including:
 - receiving, from the hearing aid transceiver assembly, the surrounding audio information;
 - sending, to the hearing aid transceiver assembly, a command to perform an audiometry test on the user;
 - 20 receiving, from the hearing aid transceiver assembly, audiometry test results when the audiometry test on the user is performed;
 - generating an audiogram for the user based on the received audiometry test results for the user;
 - generating an initial compression ratio for the user based on the
 - 25 generated audiogram for the user; and
 - generating a predicted compression ratio for the user based on the generated initial compression ratio;
 - a compression ratio tuner processor, the compression ratio tuner processor configured to:
 - 30 perform a subsequent test for the user, the subsequent test including applying the generated predicted compression ratio for the user to the surrounding audio information;

receive, from the user, subsequent test results for the user based on the subsequent test for the user; and

a feedback control processor, the feedback control processor configured to:

generate an optimized predicted compression ratios for the user based

5 on the subsequent test results; and

apply the optimized predicted compression ratio for the user to the hearing aid assembly.

2. The system as claimed in claim 1, wherein the audiometric processor is further configured to:

10 generate an insertion gain for the user based on the generated audiogram for the user; wherein the generating of the predicted compression ratio for the user is further based on the generated insertion gain for the user.

3. The system as claimed in claim 1, wherein the hearing aid assembly is further configured to receive one or more other information, including information pertaining to
15 date, time, pressure, humidity, geolocation, pressure, etc.

4. The system as claimed in claim 3, wherein the hearing aid assembly is further configured to receive one or more other information, including information pertaining to hearing condition of the user, overall health condition of the user, etc.

5. The system as claimed in claim 1, wherein the surrounding audio information is
20 obtained from at least one of the following:

the hearing aid assembly; and/or

the main processor.

6. The system as claimed in claim 1, wherein the main processor continuously receives the surrounding audio information in real-time;

25 wherein at least one of the following apply:

the surrounding audio information includes a first surrounding audio obtained at a first time, wherein the audiometry test is performed based on the first surrounding audio; and/or

30 the surrounding audio information includes a second surrounding audio obtained at a second time after the first time, wherein the audio test is performed based on the second surrounding audio; and/or

the main processor performs the subsequent test based on the first and second surrounding audio information.

7. The system as claimed in claim 1, wherein the compression ratio tuner processor is further configured to:

perform one or more additional subsequent tests for the user after performing the subsequent test for the user, including:

5 perform a second subsequent test for the user and receive second subsequent test results based on the second subsequent test performed for the user, wherein the performing of the second subsequent test for the user includes:

applying the optimized predicted compression ratio for the user to the surrounding audio information;

10 generating a second optimized predicted compression ratio for the user based on the second subsequent test results; and

applying, to the hearing aid assembly, the second optimized predicted compression ratio for the user.

8. The system as claimed in claim 1, wherein the hearing aid assembly is further
15 configured to perform the audiometry test, the audiometry test including pure tone audiometry, speech audiometry, speech-in-noise test, and/or noise-masked pure tone audiometry.

9. The system as claimed in claim 1, wherein the hearing aid assembly is further configured to:

20 collect information on a stimulus generated during the audiometry test, including frequencies, intensities, thresholds, and/or duration;

collect information on a response from the user, including response time, response accuracy, and/or response latency; and

25 process the collected information on the stimulus and the response for the audiometric processor to generate the audiogram.

10. The system as claimed in claim 1, wherein the audiometric processor is further configured to:

emit a stimulus having a frequency from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches;

30 receive, from the user, an indication of whether the user is able to hear the stimulus in each frequency; and

analyze a hearing condition of the user for each frequency based on the results of the audiometry test.

11. The system as claimed in claim 1, wherein the audiometry test includes 2-20 batches, in each batch including an increase for a period of 10-500 milliseconds followed by a period of 10-500 milliseconds of silence.
12. The system of claim 1, wherein the audiometric processor is further configured to:
- 5 store the initial compression ratio, the predicted compression ratio, and/or the optimized predicted compression ratio for artificial intelligence model training;
- wherein the generating of the predicted compression ratio and/or the optimized predicted compression ratio for the user is based on the artificial intelligence model training.
13. The system as claimed in claim 1, wherein the audiometric processor is further
- 10 configured to determine a threshold of compression for each of the one or more predicted compression ratios, the threshold of compression is determined based on one or more characteristics of the surrounding audio information received by the hearing aid assembly.
14. The system as claimed in claim 13, wherein the compression ratio tuner processor is further configured to convert the surrounding audio information, as received in real-time,
- 15 into the compressed surrounding audio information, including:
- receiving the surrounding audio information as captured by the hearing aid assembly;
- analyzing the surrounding audio information, the analysis including determining one or more characteristics of the surrounding audio information;
- 20 analyzing the surrounding audio information, the analysis including determining a compression threshold based on the one or more characteristics of the surrounding audio information;
- receiving one or more predicted compression ratios from the audiometric processor based on the determined characteristics of the surrounding audio information;
- 25 comparing the compression threshold of the surrounding audio information with the predetermined thresholds of compression for the predicted compression ratios;
- responsive to a determination that the compression threshold of the surrounding audio information is within the predetermined threshold of compression for the predicted compression ratio;
- 30 applying the one or more predicted compression ratios to the surrounding audio information to arrive at one or more compressed surrounding audio information.

15. The system as claimed in claim 1, wherein the compression ratio tuner processor is further configured to receive, during the subsequent test, the one or more feedback by the user for the one or more compressed surrounding audio information, the feedback is in the form of textual input.

- 5 16. The system as claimed in claim 15, wherein the compression ratio tuner processor further includes a textual input assessor, the textual input assessor is configured to process the textual input to arrive at one or more feedback data, the processing of the textual input includes:

10 receiving the textual input on the compressed surrounding audio information by the user from the surrounding audio generator;

assessing the textual input to predict a weighing factor for each of the textual input for each generated predicted compression ratio, the weighing factor predicted based on the one or more feedback data; and

15 communicating the feedback data for each generated predicted compression ratio and the compressed surrounding audio information to the feedback control processor.

17. The system as claimed in claim 1, wherein the subsequent test results received by the compression ratio tuner processor includes feedback from the user, the feedback including information in the form of ratings, wherein the ratings are spatial axis ratings.

- 20 18. The system as claimed in claim 17, wherein the compression ratio tuner processor further includes a spatial axis rating assessor, the spatial axis rating assessor configured to process subjective feedback to arrive at one or more feedback data, the processing includes:

receiving the subjective feedback on the compressed surrounding audio information by the user from the surrounding audio generator;

25 responsive to a determination, by the user, a subjective feedback of the compressed surrounding audio information:

plotting the subjective feedback including a soft, loud, muffled, clear, etc. audio;

30 determining a discount coefficient based on the subjective feedback plotted on the spatial axis for each generated predicted compression ratio, the discount coefficient is the one or more feedback data; and

communicating the feedback data for each generated predicted compression ratio and the compressed surrounding audio information to the feedback control processor.

19. The system as claimed in claim 1, wherein the compression ratio tuner processor is further configured to receive, during the subsequent test, the one or more feedback by the user for the one or more compressed surrounding audio information, the feedback is in the form of ranking, wherein the ranking is a preference ranking.
- 5 20. The system as claimed in claim 19, wherein the compression ratio tuner processor further includes a preference ranking assessor; the preference ranking assessor is configured to process one or more preferences by the user on the compressed audio to arrive at one or more feedback data, the processing includes:
- 10 receiving the one or more preferences on the compressed surrounding audio information by the user from the surrounding audio generator;
- responsive to a determination on the preference for each compressed surrounding audio information of the surrounding audio information:
- assigning a rating to each of the compressed surrounding audio information based on the preference determined by the user; and
- 15 communicating the feedback data for each generated predicted compression ratio and the compressed surrounding audio information to the feedback control processor.
21. The system as claimed in any of claims 15 to 20, wherein the feedback control processor is further configured to continuously receive the feedback data on one or more compressed surrounding audio information to perform an artificial intelligence (AI) model
- 20 training to arrive at a trained AI model for generating the optimized predicted compression ratios for one or more corresponding surrounding audio information.
22. The system as claimed in claim 1, wherein at least one of the following apply:
- the main processor includes a mobile device of the user; and/or
- the main processor is integrated with the hearing aid assembly of the user; and/or
- 25 the hearing aid assembly is a bone conduction hearing device of the user;
- the audio related information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is within a threshold distance from a current location of the user; and/or
- the audio related information includes historic audio information, the historic audio
- 30 information being audio information previously obtained from a geolocation that is within a threshold area from a current location of the user; and/or
- the audio related information includes audio related information generated by artificial intelligence.

23. A hearing aid system, the hearing aid system comprising:
a hearing aid assembly, the hearing aid assembly configured to be securable to a user, the hearing aid assembly, including:
a hearing aid transceiver assembly, the hearing aid transceiver assembly
5 configured to:
selectively emit audio signals to the user based on instructions received from a main processor; and
obtain surrounding audio information, the surrounding audio information including real-time surrounding audio-related information of a surrounding
10 environment of the hearing aid assembly;
a main processor, the main processor is in communication with the hearing aid assembly, the main processor including:
an audiometric processor, the audiometric processor configured to perform an audiogram generation process, the audiogram generation process including:
15 receiving, from the hearing aid transceiver assembly, a first surrounding audio information;
receiving, from the hearing aid transceiver assembly, audiometry test results when an audiometry test is performed on the user;
generating an audiogram for the user based on the received
20 audiometry test results for the user;
generating an initial compression ratio for the user based on the generated audiogram for the user; and
generating a predicted compression ratio for the user using an artificial intelligence (AI) training model;
25 a compression ratio tuner processor, the compression ratio tuner processor configured to:
perform a subsequent test for the user, the subsequent test including applying the generated predicted compression ratio for the user to a second surrounding audio information;
30 receive, from the user, subsequent test results for the user based on the subsequent test for the user; and
a feedback control processor, the feedback control processor configured to:

generate an optimized predicted compression ratios for the user based on the subsequent test results; and

apply the optimized predicted compression ratio for the user to the hearing aid assembly.

- 5 24. The system as claimed in claim 23, wherein the audiometric processor is further configured to:

generate an insertion gain for the user based on the generated audiogram for the user; wherein the generating of the predicted compression ratio for the user is further based on the generated insertion gain for the user.

- 10 25. The system as claimed in claim 23, wherein the hearing aid assembly is further configured to receive one or more other information, including information pertaining to date, time, pressure, humidity, geolocation, pressure, etc.

26. The system as claimed in claim 25, wherein the hearing aid assembly is further configured to receive one or more information, including information pertaining to hearing
15 condition of the user, overall health condition of the user, etc.

27. The system as claimed in claim 23, wherein the surrounding audio information is obtained from at least one of the following:

the hearing aid assembly; and/or
the main processor.

- 20 28. The system as claimed in claim 23, wherein the main processor continuously receives the surrounding audio information in real-time;

wherein at least one of the following apply:

- the surrounding audio information includes a first surrounding audio obtained at a first time, wherein the main processor performs the audiometry test based on
25 the first surrounding audio; and/or

the surrounding audio information includes a second surrounding audio obtained at a second time after the first time, wherein the main processor performs the subsequent test based on the second surrounding audio; and/or

- the main processor performs the subsequent test based on the first and second
30 surrounding audio information.

29. The system as claimed in claim 23, wherein the compression ratio tuner processor is further configured to:

perform one or more additional subsequent test for the user after performing the subsequent test for the user, including:

performing a second subsequent test for the user and receive second subsequent test results based on the second subsequent test performed for the user, wherein the performing

5 of the second subsequent test for the user includes:

applying the optimized predicted compression ratio for the user to the surrounding audio information;

generating a second optimized predicted compression ratio for the user based on the second subsequent test results; and

10 applying, to the hearing aid assembly, the second optimized predicted compression ratio for the user.

30. The system as claimed in claim 23, wherein the hearing aid assembly is further configured to perform the audiometry test, the audiometry module including pure tone audiometry, speech audiometry, speech-in-noise test, and/or noise-masked pure tone

15 audiometry.

31. The system as claimed in claim 23, wherein the hearing aid assembly is further configured to:

collect information on a stimulus generated during the audiometry test, including frequencies, intensities, thresholds, duration, etc.;

20 collect information on the response from the user including response time, response accuracy, and/or response latency; and

process the collected information on the stimulus and the response for the audiometric processor to generate the audiogram.

32. The system as claimed in claim 23, wherein the audiometric processor is further
25 configured to:

emit a stimulus having a frequency from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches;

receive, from the user, an indication of whether the user is able to hear the stimulus in each frequency; and

30 analyzing a hearing condition of the user for each frequency based on the results of the audiometry test.

33. The system as claimed in claim 23, wherein the audiometry test includes 2-20 batches, in each batch including an increase for a period of 10-500 milliseconds followed by a period of 10-500 milliseconds of silence.

34. The system of claim 23, wherein the audiometric processor is further configured to:
5 storing the initial compression ratio, the predicted compression ratio, and/or the optimized predicted compression ratio for artificial intelligence model training;

wherein the generating of the predicted compression ratio and/or the optimized predicted compression ratio for the user is based on the artificial intelligence model training.

35. The system as claimed in claim 23, wherein the audiometric processor is further
10 configured to determine a threshold of compression for each of the one or more predicted compression ratios, the threshold of compression is determined based on one or more characteristics of the surrounding audio information received by the hearing aid assembly.

36. The system as claimed in claim 35, wherein the compression ratio tuner processor is further configured to convert the surrounding audio information, as received in real-time,
15 into the compressed surrounding audio information, including:

receiving the surrounding audio information as captured by the hearing aid assembly;

analyzing the surrounding audio information, the analysis including determining one or more characteristics of the surrounding audio information;

20 analyzing the surrounding audio information, the analysis including determining a compression threshold based on the one or more characteristics of the surrounding audio information;

receiving one or more predicted compression ratios from the audiometric processor based on the determined characteristics of the surrounding audio information;

25 comparing the compression threshold of the surrounding audio information with the predetermined threshold of compression for the predicted compression ratios;

responsive to a determination that the compression threshold of the surrounding audio information is within the predetermined threshold of compression for the predicted compression ratio;

30 applying the one or more predicted compression ratios to the surrounding audio information to arrive at one or more compressed surrounding audio information.

37. The system as claimed in claim 23, wherein the compression ratio tuner processor is further configured to receive, during the subsequent test, the one or more feedback by the user for the one or more compressed surrounding audio information, the feedback is in the form of textual input.

5 38. The system as claimed in claim 37, wherein the compression ratio tuner processor further includes a textual input assessor, the textual input assessor is configured to process the textual input to arrive at one or more feedback data, the processing includes:

receiving the textual input on the compressed surrounding audio information by the user from the surrounding audio generator;

10 assessing the textual input to predict a weighing factor for each of the textual input for each generated predicted compression ratio, the weighing factor is the one or more feedback data; and

communicating the feedback data for each generated predicted compression ratio and the compressed surrounding audio information to the feedback control processor.

15 39. The system as claimed in claim 23, wherein the subsequent test results received by the compression ratio tuner processor includes feedback from the user, the feedback including information in the form of rating, wherein the ratings are spatial axis ratings.

40. The system as claimed in claim 39, wherein the compression ratio tuner processor further includes a spatial axis rating assessor, the spatial axis rating assessor is configured
20 to process subjective feedback to arrive at one or more feedback data, the processing includes:

receiving the subjective feedback on the compressed surrounding audio information by the user from the surrounding audio generator;

responsive to a determination, by the user, a subjective feedback of the compressed
25 surrounding audio information:

plotting the subjective feedback including a soft, loud, muffled, clear, etc. audio;

determining a discount coefficient based on the subjective feedback plotted on the spatial axis for each generated predicted compression ratio, the discount coefficient
30 is the one or more feedback data; and

communicating the feedback data for each generated predicted compression ratio and the compressed surrounding audio information to the feedback control processor.

41. The system as claimed in claim 23, wherein the compression ratio tuner processor further configured to receive, during the subsequent test, the one or more feedback by the user for the one or more compressed surrounding audio information, the feedback is in the form of ranking, wherein the ranking is a preference ranking.
- 5 42. The system as claimed in claim 41, wherein the compression ratio tuner processor further includes a preference ranking assessor; the preference ranking assessor is configured to process one or more preferences by the user on the compressed audio to arrive at one or more feedback data, the processing includes:
- receiving the one or more preferences on the compressed surrounding audio
10 information by the user from the surrounding audio generator;
- responsive to a determination on the preference for each compressed surrounding audio information of the surrounding audio information:
- assigning a rating to each of the compressed surrounding audio information based on the preference determined by the user; and
- 15 communicating the feedback data for each generated predicted compression ratio and the compressed surrounding audio information to the feedback control processor.
43. The system as claimed in any of claims 37 to 42, wherein the feedback control processor is further configured to continuously receive the feedback data on one or more compressed surrounding audio information to perform an artificial intelligence (AI) model
20 training to arrive at a trained AI model for generating the optimized predicted compression ratios for one or more corresponding surrounding audio information.
44. The system as claimed in claim 23, wherein the feedback control processor is further configured to generate a predicted real-time compression ratio, including:
- performing an AI model training using the compressed surrounding audio
25 information and the feedback data to arrive at a trained AI model; and
- responsive to receiving a real-time surrounding environmental audio;
- applying the real-time surrounding environmental audio to the trained AI model to generate real-time compression ratios; and
- applying the generated real-time compression ratios to the hearing aid
30 assembly.
45. The system as claimed in claim 23, wherein at least one of the following apply:
- the main processor includes a mobile device of the user; and/or
- the main processor is integrated with the hearing aid assembly of the user; and/or

the hearing aid assembly is a bone conduction hearing device of the user;

the audio related information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is within a threshold distance from a current location of the user; and/or

5 the audio related information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is within a threshold area from a current location of the user; and/or

the audio related information includes audio related information generated by artificial intelligence.

10 46. A method for managing a hearing aid assembly , the method comprising:

establishing, for the user, a communication channel between a processor and the hearing aid device of the user;

performing, by the processor via the communication channel, an audiogram generation process, the audiogram generation process including:

15 receiving, by the processor, surrounding audio information, the surrounding audio information including real-time audio-related information of a surrounding environment of the hearing aid assembly;

performing, by the processor via the hearing aid assembly, an initial audiometry test for the user;

20 receiving, by the processor, initial audiometry test results for the user based on the initial audiometry test performed for the user;

responsive to receiving the surrounding audio information and the initial audiometry test results:

25 generating, by the processor, an audiogram for the user based on at least the surrounding audio information and the initial audiometry test results;

generating, by the processor based on the audiogram for the user, an initial compression ratio for the user;

generating, by the processor based on the initial compression ratio for the user, a predicted compression ratio for the user;

30 performing, by the processor, a subsequent test for the user, the subsequent test including applying the generated predicted compression ratio for the user to the surrounding audio information;

receiving, by the processor from the user, subsequent test results for the user based on the subsequent test performed for the user;

generating, by the processor, an optimized predicted compression ratio for the user based on subsequent test results; and

5 applying, by the processor to the hearing aid assembly, the optimized predicted compression ratio for the user.

47. The method as claimed in claim 46, further comprising:

generating an insertion gain for the user based on the generated audiogram for the user;

10 wherein the generating of the predicted compression ratio for the user is further based on the generated insertion gain for the user.

48. The method as claimed in claim 45, wherein the method includes receiving one or more information on the surrounding audio information including at least one date, time, pressure, humidity, geolocation, pressure, etc.

15 49. The method of claim 45, wherein the surrounding audio information is obtained from at least one of the following:

the hearing aid assembly ; and/or
the processor.

50. The method of claim 45,

20 wherein the processor continuously receives surrounding audio information in real-time;

wherein at least one of the following apply:

the surrounding audio information includes a first surrounding audio information obtained at a first time, wherein the processor performs the initial audiometry test based on the first surrounding audio information; and/or

25 the surrounding audio information includes a second surrounding audio information obtained at a second time after the first time, wherein the processor performs the subsequent test based on the second surrounding audio information; and/or

30 the processor performs the subsequent test based on the first and second surrounding audio information.

51. The method of claim 45, further comprising:

performing, by the processor, one or more additional subsequent tests for the user after performing the subsequent test for the user, including:

performing a second subsequent test for the user and receiving second subsequent test results based on the second subsequent test performed for the user, wherein the performing of the second subsequent test for the user includes:

5 applying the optimized predicted compression ratio for the user to the surrounding audio information;

 generating a second optimized predicted compression ratio for the user based on the second subsequent test results; and

 applying, to the hearing aid assembly, the second optimized predicted compression ratio for the user.

10 52. The method as claimed in claim 45, wherein the audiogram generation process further includes:

 emitting a stimulus having a frequency from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches;

15 receiving, from the user, an indication of whether the user is able to hear the stimulus in each frequency; and

 analyzing a hearing condition of the user for each frequency based on the results of the audiometry test.

53. The method as claimed in claim 45, wherein the initial audiometry test includes 2-20 batches, in each batch including an increase for a period of 10-500 milliseconds followed
20 by a period of 10-500 milliseconds of silence.

54. The method of claim 45, wherein the performing, by a processor for the user, of the audiogram generation process further includes:

 storing the initial compression ratio, the predicted compression ratio, and/or the optimized predicted compression ratio for artificial intelligence model training;

25 wherein the generating of the predicted compression ratio and/or the optimized predicted compression ratio for the user is based on the artificial intelligence model training.

55. The method of claim 45, wherein the feedback includes at least one of the following:
 textual input from the user describing a result of the applying of the generated predicted compression ratio to the surrounding audio information; and/or

30 a rating from the user the rating including an indication of whether the result of the applying of the generated predicted compression ratio to the surrounding audio information resulted in changes, including clearer audio, muffled audio, loud audio, and/or dimmed audio.

56. The method of claim 53, wherein the textual input is provided as input to a large language model (LLM), the LLM is configured to capture a word context and predict a weighing factor of each set of the audio sound.
- 5 57. The method of claim 53, wherein the rating is described as a scale to determine a discount coefficient for further predicting an adjusted predicted compression ratio.
58. The method of claim 45, wherein at least one of the following apply:
- the processor includes a mobile device of the user; and/or
- the processor is integrated with the hearing aid assembly of the user; and/or
- 10 the hearing aid assembly is a bone conduction hearing device of the user;
- the communication channel is a wireless communication channel;
- the surrounding audio information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is within a threshold distance from a current location of the user; and/or
- 15 the surrounding audio information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is within a threshold area from a current location of the user; and/or
- the surrounding audio information includes audio information generated by artificial intelligence.
- 20 59. A method for managing a hearing aid assembly, the method comprising:
- performing, by the processor, an audiogram generation process, the audiogram generation process including:
- performing, via the hearing aid assembly, an initial audiometry test for the user;
- 25 receiving, by the processor, initial audiometry test results for the user based on the initial audiometry test performed for the user;
- responsive to receiving the initial audiometry test results:
- generating, by the processor, an initial compression ratio for the user,
- the initial compression ratio for the user generated based on at least the initial audiometry
- 30 test results;
- generating, by the processor, a predicted compression ratio for the user, the predicted compression ratio for the user generated based on at least the initial compression ratio for the user;

performing, by the processor, a subsequent test for the user, the subsequent test configured based on the generated predicted compression ratio for the user;

receiving, by the processor, subsequent test results for the user based on the subsequent test performed for the user;

5 generating, by the processor, an optimized predicted compression ratio for the user based on the subsequent test results; and

applying, by the processor to the hearing aid assembly, the optimized predicted compression ratio for the user.

60. The method as claimed in claim 59, further comprising:

10 generating an insertion gain for the user based on the generated audiogram for the user;

wherein the generating of the predicted compression ratio for the user is further based on the generated insertion gain for the user.

61. The method of claim 59, wherein the method includes receiving one or more
15 information on the surrounding audio information including at least one date, time, pressure, humidity, geolocation, pressure, etc.

62. The method of claim 59, wherein the surrounding audio information is obtained from at least one of the following:

the hearing aid assembly ; and/or

20 the processor.

63. The method of claim 59,

wherein the processor continuously receives surrounding audio information in real-time;

wherein at least one of the following apply:

25 the surrounding audio information includes a first surrounding audio information obtained at a first time, wherein the processor performs the initial audiometry test based on the first surrounding audio information; and/or

the surrounding audio information includes a second surrounding audio information obtained at a second time after the first time, wherein the processor performs

30 the subsequent test based on the second surrounding audio information; and/or

the processor performs the subsequent test based on the first and second surrounding audio information.

64. The method of claim 59, further comprising:
performing, by the processor, one or more additional subsequent tests for the user after performing the subsequent test for the user, including:
performing a second subsequent test for the user and receiving second
5 subsequent test results based on the second subsequent test performed for the user, wherein the performing of the second subsequent test for the user includes:
applying the optimized predicted compression ratio for the user to the surrounding audio information;
generating a second optimized predicted compression ratio for the
10 user based on the second subsequent test results; and
applying, to the hearing aid assembly, the second optimized predicted compression ratio for the user.
65. The method as claimed in claim 59, wherein the audiogram generation process further includes:
15 emitting a stimulus having a frequency from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches;
receiving, from the user, an indication of whether the user is able to hear the stimulus in each frequency; and
analyzing a hearing condition of the user for each frequency based on the results of
20 the audiometry test.
66. The method as claimed in claim 59, wherein the initial audiometry test includes 2-20 batches, each batch including an increase in volume for a period of 10-500 milliseconds followed by a period of 10-500 milliseconds of silence.
67. The method of claim 59, wherein the performing of the audiogram generation
25 process further includes:
storing the initial compression ratio, the predicted compression ratio, and/or the optimized predicted compression ratio for artificial intelligence model training;
wherein the generating of the predicted compression ratio and/or the optimized predicted compression ratio for the user is based on the artificial intelligence model training.
- 30 68. The method of claim 59, wherein subsequent test results for the user includes at least one of the following:
textual input from the user describing a result of the applying of the generated predicted compression ratio to the surrounding audio information; and/or

a rating from the user, the rating including an indication of whether the result of the applying of the generated predicted compression ratio to the surrounding audio information resulted in changes, including clearer audio, muffled audio, loud audio, and/or dimmed audio.

5 69. The method of claim 59, wherein the textual input is provides as input to a large language model (LLM), the LLM is configured to capture a word context and predict a weighing factor of each set of the audio sound.

70. The method of claim 59, wherein the rating is described as a scale to determine a discount coefficient for further predicting an adjusted predicted compression ratio.

10 71. The method of claim 59, wherein at least one of the following apply:

the processor includes a mobile device of the user; and/or

the processor is integrated with the hearing aid assembly of the user; and/or

the hearing aid assembly is a bone conduction hearing device of the user;

the communication channel is a wireless communication channel;

15 the surrounding audio information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is within a threshold distance from a current location of the user;

the surrounding audio information includes historic audio information, the historic audio information being audio information previously obtained from a geolocation that is

20 within a threshold area from a current location of the user; and/or

the surrounding audio information includes audio information generated by artificial intelligence.

72. A hearing aid system, the hearing aid system comprising:

25 a hearing aid assembly, the hearing aid assembly configured to be securable to a user, the hearing aid assembly including:

a hearing aid transceiver assembly, the hearing aid transceiver assembly configured to:

selectively emit audio signals to the user, the audio signals including pure tone signals; and

30 obtain surrounding audio information, the surrounding audio information including real-time surrounding audio-related information;

a digital signal processor, the digital signal processor configured to perform a surrounding audio adjustment process;

a main processor, the main processor in communication with the hearing aid assembly, the main processor including:

an audiometric profile processor, the audiometric profile processor configured to perform an audiometric profile generation process, the audiometric profile generation process including:

sending, to the hearing aid transceiver assembly, a command to perform an audiometry test on the user, the audiometry test including the hearing aid transceiver assembly emitting pure tone signals to the user;

receiving, from the hearing aid transceiver assembly, audiometry test results, the audiometry test results including a hearing threshold of the user based on the audiometry test performed on the user;

generating an audiometric profile for the user based on the received hearing threshold of the user; and

sending the audiometric profile to a hearing profile processor;

the hearing profile processor, the hearing profile processor configured to perform a hearing profile generation process, the hearing profile generation process including:

receiving, from the audiometric profile processor, the audiometric profile;

generating, based on the received audiometric profile, a hearing profile for the user, the hearing profile having at least one hearing parameter for audio processing;

performing a hearing profile optimization process to generate an optimized hearing profile; and

instructing the hearing aid assembly to perform the surrounding audio adjustment process based on the optimized hearing profile by sending the optimized hearing profile to the hearing aid transceiver assembly and instructing the digital signal processor to perform the surrounding audio adjustment process, wherein the surrounding audio adjustment process includes:

receiving, from the hearing aid transceiver assembly, the surrounding audio information;

determining, based on the surrounding audio information, an environment classifier, the environment classifier being a classification of a current

surrounding environment of the user determined based on the received surrounding audio information; and

generating an adjusted audio output for the user by adjusting, based on the environment classifier and the optimized hearing profile, one or more audio processing parameters of the surrounding audio information.

73. The system as claimed in claim 72, wherein the hearing aid assembly is further configured to perform the audiometry test, the audiometry test including pure tone audiometry, speech audiometry, speech-in-noise test, and/or noise-masked pure tone audiometry.

74. The system as claimed in claim 72, wherein the hearing aid assembly is further configured to:

collect information on the audio signals generated during the audiometry test, including frequencies, intensities, thresholds, and/or duration;

collect information on responses from the user, including response time, response accuracy, and/or response latency; and

process the collected information on the audio signals and the responses for the audiometry profile processor to generate an audiogram, the audiogram is part of the audiometric profile.

75. The system as claimed in claim 72, wherein the hearing aid transceiver assembly is further configured to:

emit pure tone signals having frequencies from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches;

receive, from the user, one or more determination on whether the user is able to hear the audio signal in each frequency; and

analyze a hearing condition of the user for each frequency based on the results of the audiometry test.

76. The system as claimed in claim 75, wherein the audiometry test includes 2-20 batches, in each batch including an increase for a period of 10-500 milliseconds followed by a period of 10-500 milliseconds of silence.

77. The system as claimed in claim 72, wherein the hearing aid assembly further includes a crossover detection module of the audiometric profile processor, the crossover detection module is configured to manage crossovers during the audiometry test, the managing includes:

receiving one or more determination from the user indicating an occurrence of a crossover, the crossover occurs when a test pure tone signal presented to a target ear is perceived by a non-target ear;

responsive to a determination, by the user, a test pure tone signal presented to a target
5 ear is perceived by a non-target ear:

enable a user interface comprising user guided control elements configured to allow adjustments to spatial presentation of the test pure tone signal;

receiving, from the user, an input on the adjustments to the spatial presentation; and

10 reposition the spatial presentation of the test pure tone signal to a midline location.

78. The system as claimed in claim 71, wherein the crossover detection module having a correction module configured to:

receive one or more user based input of the spatial presentation of the test pure tone
15 signal from the user; and

adjust the hearing threshold of the user based on the input of the spatial presentation of the test pure tone signal from the user, the adjustments resulting in a corrected audiometry test results.

79. The system as claimed in claim 78, wherein the crossover during the audiometry
20 test are managed in real-time or almost real-time.

80. The system as claimed in claim 71, wherein the hearing profile processor, when generating the hearing profile, is further configured to determine at least one of the following hearing parameters: compression ratio, insertion gain, soft gain, moderate gain, loud gain, and/or any other audio/signal processing parameters.

25 81. The system of claim 72, wherein the hearing profile processor is further configured to:

store the compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters for artificial intelligence model training;

wherein the generating of the hearing profile for the user is based on the artificial
30 intelligence model training.

82. The system as claimed in claim 72, wherein the hearing profile processor is further configured to determine a value for each of the compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters, the

determination is based on one or more characteristics of the surrounding audio received by the hearing aid assembly and the audiometric profile.

83. The system as claimed in claim 72, wherein the hearing profile optimization process includes:

5 receiving, from the hearing aid transceiver assembly, the surrounding audio information;

performing a subsequent test for the user, the subsequent test including applying the generated hearing profile for the user to the received surrounding audio information;

10 receiving, from the user, one or more subsequent test results based on the subsequent test for the user;

generating, an optimized hearing profile for the user based on the subsequent test results; and

15 storing, the optimized hearing profile for the user in the hearing profile processor.

84. The system as claimed in claim 72, wherein the hearing profile processor is further configured to receive, during the subsequent test, one or more feedback by the user for the one or more received surrounding audio information, the feedback is in the form of textual input.

20 85. The system as claimed in claim 84, wherein the hearing profile processor further includes a textual input assessor, the textual input assessor is configured to process the textual input to arrive at one or more feedback data, the processing of the textual input includes:

25 receiving the textual input on the received surrounding audio information by the user from the hearing aid transceiver assembly;

assessing the textual input to predict a weighing factor for each of the textual input for each received surrounding audio information, the weighing factor predicted based on the one or more feedback data; and

30 storing the feedback data for each generated hearing profile and the received surrounding audio information to the hearing profile processor.

86. The system as claimed in claim 72, wherein the hearing profile processor is further configured to receive, during the subsequent test, one or more feedback by the user for the

one or more received surrounding audio information, the feedback including information in the form of ratings, wherein the ratings are spatial axis ratings.

87. The system as claimed in claim 86, wherein the hearing profile processor further includes a spatial axis rating assessor, the spatial axis rating assessor configured to process
5 subjective feedback to arrive at one or more feedback data, the processing includes:

receiving the subjective feedback on the received surrounding audio information by the user from the hearing aid transceiver assembly;

responsive to a determination, by the user, a subjective feedback of the received surrounding audio information:

10 plotting the subjective feedback including a soft, loud, muffled, clear, etc. audio;

determining a discount coefficient based on the subjective feedback plotted on the spatial axis for each received surrounding audio information, the discount coefficient is the one or more feedback data; and

15 storing the feedback data for each generated hearing profile and the received surrounding audio information in the hearing profile processor.

88. The system as claimed in claim 72, wherein the hearing profile processor is further configured to receive, during the subsequent test, one or more feedback by the user for the one or more received surrounding audio information, the feedback is in the form of ranking,
20 wherein the ranking is a preference ranking.

89. The system as claimed in claim 88, wherein the hearing profile processor further includes a preference ranking assessor, the preference ranking assessor is configured to process one or more preferences by the user on the received surrounding audio information at one or more feedback data, the processing includes:

25 receiving the one or more preferences on the received surrounding audio information by the user from the hearing aid transceiver assembly;

responsive to a determination on the preference for each received surrounding audio information:

30 assigning a rating to each of the received surrounding audio information based on the preference determined by the user; and

storing the feedback data for each generated hearing profile and the received surrounding audio information in the hearing profile processor.

90. The system as claimed in claim 72, wherein the digital signal processor is further configured to adjust the surrounding audio, as received in real-time, into the audio output, including:

5 determining, via a signal processing module, the surrounding audio to determine optimal values of the audio/signal processing parameters based on the hearing profile, environment classifier, and/or the surrounding audio; and

applying, via the signal processing module, the determined optimal values of the audio/signal processing parameters to the surrounding audio to arrive at the audio output for playback to the user.

10 91. The system as claimed in claim 90, wherein the hearing profile processor is further configured to continuously receive feedback data on one or more surrounding audio to perform an artificial intelligence (AI) model training to arrive at a trained artificial intelligence (AI) model for generating the optimal values of the audio/signal processing parameters.

15 92. A method for managing a hearing aid assembly, the method comprising:

establishing, for a user, a communication channel between a main processor and the hearing aid device of the user;

performing, by the processor via the communication channel, an audiometric profile generation process, the audiometric profile generation process including:

20 sending, by the processor, command to perform an audiometry test on the user, the audiometry test includes the hearing aid transceiver assembly emitting pure tone signals to the user;

receiving, from the hearing aid transceiver assembly, audiometry test results, the audiometry test results including a hearing threshold of the user based on the audiometry test performed on the user;

25 generating an audiometric profile for the user based on the received hearing threshold of the user; and

sending the audiometric profile to a hearing profile processor;

performing, by the processor via the communication channel, a hearing profile generation process, the hearing profile generation process including:

receiving, from the audiometric profile processor, the audiometric profile;

generating, based on the received audiometric profile, a hearing profile for the user, the hearing profile having at least one hearing parameter for audio processing;

performing a hearing profile optimization process to generate an optimized hearing profile; and

instructing the hearing aid assembly to perform the surrounding audio adjustment process based on the optimized hearing profile by sending the optimized hearing profile to the hearing aid transceiver assembly and instructing the hearing aid transceiver assembly to perform the surrounding audio adjustment process, wherein the surrounding audio adjustment process includes:

receiving, from the hearing aid transceiver assembly, the surrounding audio information;

determining, based on the surrounding audio information, an environment classifier, the environment classifier being a classification of a current surrounding environment of the user determined based on the received surrounding audio information; and

generating an adjusted audio output for the user by adjusting, based on the environment classifier and the optimized hearing profile, one or more audio processing parameters of the surrounding audio information..

93. The method for as claimed in claim 92, wherein the audiometry test includes pure tone audiometry, speech audiometry, speech-in-noise test, and/or noise-masked pure tone audiometry.

94. The method for as claimed in claim 92, wherein the method further includes:

collecting information on the audio signals generated during the audiometry test, including frequencies, intensities, thresholds, and/or duration;

collecting information on responses from the user, including response time, response accuracy, and/or response latency; and

processing the collected information on the audio signals and the responses for the audiometry profile processor to generate an audiogram, the audiogram is part of the audiometric profile.

95. The method for as claimed in claim 92, wherein the method further includes:

emitting pure tone signals having frequencies from 125 to 8,000 Hz for a period of 200 to 800 milliseconds in a plurality of batches;

receiving, from the user, one or more determination on whether the user is able to hear the audio signal in each frequency; and

analyzing a hearing condition of the user for each frequency based on the results of the audiometry test.

96. The method as claimed in claim 92, wherein the audiometry test includes 2-20 batches, in each batch including an increase for a period of 10-500 milliseconds followed
5 by a period of 10-500 milliseconds of silence.

97. The method as claimed in claim 92, wherein the method further includes performing, by the processor, a crossover management process, the crossover management process including:

receiving one or more determination from the user indicating an occurrence of a
10 crossover, the crossover occurs when a test pure tone signal presented to a target ear is perceived by a non-target ear;

responsive to a determination, by the user, a test pure tone signal presented to a target ear is perceived by a non-target ear:

enabling a user interface comprising user guided control elements configured
15 to allow adjustments to spatial presentation of the test pure tone signal;

receiving, from the user, an input on the adjustments to the spatial presentation; and

repositioning the spatial presentation of the test pure tone signal to a midline location.

20 98. The method as claimed in claim 92, wherein the method further includes performing the crossover management process using a correction module configured to:

receive one or more user based input of the spatial presentation of the test pure tone signal from the user; and

adjust the hearing thresholds of the user based on the input of the spatial presentation
25 of the test pure tone signal from the user, the adjustments resulting in a corrected audiometry test results.

99. The method as claimed in claim 98, wherein the crossover during the audiometry test are managed in real-time or almost real-time.

100. The method as claimed in claim 92, wherein the method further includes, when
30 generating the hearing profile, determining at least one of the following hearing parameters: compression ratio, insertion gain, soft gain, moderate gain, loud gain, and/or any other audio/signal processing parameters.

101. The method as claimed in claim 92, wherein the method further includes storing the compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters for artificial intelligence (AI) model training, the artificial intelligence (AI) is used when generating the hearing profile for the user.

5 102. The method as claimed in claim 92, wherein the method further includes determining a value or each of the compression ratio, insertion gain, soft gain, moderate gain, loud gain, or any other audio/signal processing parameters, the determination is based on one or more characteristics of the surrounding audio received by the hearing aid assembly and the audiometric profile.

10 103. The method as claimed in claim 92, wherein the hearing profile optimization process includes:

receiving, from the hearing aid transceiver assembly, the surrounding audio information;

15 performing a subsequent test for the user, the subsequent test including applying the generated hearing profile for the user to the received surrounding audio information;

receiving, from the user, one or more subsequent test results based on the subsequent test for the user;

20 generating, an optimized hearing profile for the user based on the subsequent test results; and

storing, the optimized hearing profile for the user in the hearing profile processor.

104. The method as claimed in claim 103, wherein subsequent test results for the user includes at least one of the following:

25 textual input from the user describing a result of the applying of the generated hearing profile to the received surrounding audio information;

a rating from the user, the rating including an indication of whether the result of the applying of the generated hearing profile to the received surrounding audio information resulted in changes, including clearer audio, muffled audio, loud audio, and/or dimmed
30 audio; and/or

a ranking from the user, the ranking including an indication of the preference of the user of the applying of the generated hearing profile to the received surrounding audio information.

105. The method as claimed in claim 92, wherein the method further includes adjusting the surrounding audio, as received in real-time, into the audio output, the adjusting the surrounding audio process including:

determining, via a signal processing module, the surrounding audio to determine
5 optimal values of the audio/signal processing parameters based on the hearing profile, environment classifier, and/or the surrounding audio; and

applying, via the signal processing module, the determined optimal values of the audio/signal processing parameters to the surrounding audio to arrive at the audio output for playback to the user.

10 106. The method as claimed in claim 92, wherein the method further includes continuously receiving feedback data on one or more surrounding audio to perform an artificial intelligence (AI) model training to arrive at a trained artificial intelligence (AI) model for generating the optimal values of the audio/signal processing parameters.