

Intelligent Respiratory Mask with Sensors and Electronic Air Filtering Method

BACKGROUND OF INVENTION

Field of invention

The present invention relates to reusable respiratory mask devices and, more particularly, pertains to a new method for eliminating discomfort caused by high-breathing resistance resulting from the need to use ultra-fine air filtering materials to obstruct airborne microbial and particles, thus maximizing user safety and comfort to sustain a prolonged period of mask wearing, as well as enabling observable wearer's facial gestures and preserving voice intensity during face-to-face distancing contact with other persons in proximity.

Description of Prior art

The use of reusable respiratory masks is commonly to prevent inhaling toxic smoke, chemicals, dust and other hazardous chemical fumes. Industrial works exposing workers to fine dust particles, such as spray painting and powder coating processes require workers to wear a respiratory mask for example the N95 mask. Respiratory masks are also worn by persons whose nasal respiratory system is sensitive to airborne trees and flowers pollens prevalent during Spring. In some occasions, forest fires during Summer generated airborne smoke and fine dust particles constituting to deterioration of asthmatic patients. Respiratory masks are also commonly used in biomedical laboratories for handling microbial inside cleanroom or bench.

These respiratory masks typically used for relatively short time period within indoor work places, or during outdoor traveling limited from one location point A to point B. Masks users focus on largely on its protection effectiveness to filter out toxic fume, fine particles or microbial, covering entire head and neck, incorporating with large diameter air hose but are deprived from (i) mask wearer's facial gestures, (ii) mask aesthetic and comfort for prolonged wearing. For examples, typical respiratory mask covers most part of face preventing others from seeing wearer's facial gestures, high breathing resistance leading to tiredness or fatigue, (iii) reduction on voice intensity level obstructed by mask cover causing difficulty to hear clearly in proximity distance, especially in those relatively noisy premises, (iv) high-safety mask covering entire face including nose, mouth, eyes, hair and extending to neck used in highly contaminated premises such as intensive care unit (ICU) of a hospital is inappropriate worn in customer-facing service oriented hospitality personnel or public premises, and (vii) ease of putting on or taking out the mask disturbing one's hair posture and looks.

However, present coronavirus pandemic condition requires people to wear a mask for prolonged hours in offices, public confined spaces such as inside a train, airplane, bus, shopping malls, or nearly every premises where social gathering happen, such as café, restaurants, a party, class room, cinemas, hotel lobby, etc.

The inattentiveness of mask user needs described above constitutes to obvious shortcomings of existing respiratory masks functional designs and appearances. The present invention set forth to address the foregoing shortfalls with an intelligent respiratory mask with sensors and air filtering methods, constructed with the following characteristics which provide the public as well as medical personnel with a useful choice: (i) easy and comfortable to wear for prolonged hours, (ii) maximize safety with nanometer filtering system yet minimizing breathing resistance to negligible level, (iii) transparent front-facing mask allowing persons in proximity to see user's facial gestures, (iv) lighting up inner mask cavity area to enable facial and mouth gestures observable in less illuminated environments (v) preserving mask user's voice intensity level by incorporating miniature speakers on the mask, (vi) extend voice intensity from the mask to proximity distance with wireless Bluetooth speakers, and (vii) use of magnetic buckles in conjunction with flexible strings to ease mask fitting.

SUMMARY OF INVENTION

One aspect of present invention is to provide an intelligent respiratory mask with sensors and electronic air filtering method comprising at least a front-facing transparent housing, a plurality of sensors and switches, a microphone and speaker, interface application software and devices within the intelligent mask system and also external paired mobile devices in proximity.

The intelligent mask system may content and interact with at least an electronic air filtering module having a microcontroller, a plurality of air pumps, air tubes and application software to form an unitary embodiment of an intelligent mask and when interact in conjunction with external mobile devices, internet link to cloud storage to form an efficient intelligent mask system.

A further object of present invention is to utilize at least a microcontroller on the intelligent mask as central processing to interact with external devices in physical proximity, the said microcontroller enables the extraction of signals from various sensors communicate and display on the mobile device screen in proximity. Typical information includes (i) breathing frequency, patterns, inhaling and exhaling time periods, (ii) air flow volume channeled in and out of mask cavity, (iii) average air temperature and humidity within mask cavity (iv) breathing resistance index calculated from differential pressure with time within mask cavity, (v) time to replacement of air refill filter cartridges, (vi) breathing comfort level, (vii) total time used for the day since replacing the refill filter etc.

Present invention thus provides an intelligent respiratory mask comprising plurality of microchip sensors to aid regulating air flow for comfort required for prolonged wearing, electronically controlled nanometer multiply air filtering method, microphone and miniature speaker to maintain normal voice intensity during conversation, transparent front-facing mask allowing persons in proximity to see user's facial gestures, advantageously used to replace the use of conventional respiratory mask which their functional and appearances are not designed for used in public and customer-facing hospitality premises. These and other objects, advantages and features of invention will be apparent from the following description of a preferred embodiment, considered along with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

The details of the intelligent respiratory mask will be understood more clearly with reference made to the accompanying drawings, in which:

FIG.1 is an isometric view of an intelligent respiratory mask integral with electronic device.

FIG.2 is a front view of an intelligent respiratory mask with multiple button and speaker.

FIG.3 is a front view of an intelligent respiratory mask with transparent front-facing mask.

FIG.4 is an illustration of the intelligent respiratory mask with one directional air valve wherein the valve comprising a shutter to manually close or open-air flow.

FIG.5 is an illustration of the intelligent respiratory mask embodiment integrated with electronic circuitry module which included battery, microcontroller, microphone, electronics memory and plurality of sensing elements. The mask is comprising at least one string with magnetic buckles.

FIG.6 is an illustration of an intelligent respiratory mask and sensor data and voice information are transmitted wirelessly to external mobile device in proximity;

FIG.7 is an illustration whereas external filtered air is fed into the mask cavity with at least one electronic air filtering pump module located in proximity through air tubes. Exhaled air is channeled out from the mask cavity with the foregoing electronic air filtering pump module through separate air tubes.

FIG.8 is an illustration of an intelligent respiratory mask pairing with an external Bluetooth speaker device in proximity.

FIG.9 is a schematic illustration of the block diagram of embedded electronic circuit of FIG.1 according to the foregoing illustrated embodiments; and

FIG.10 is a schematic illustration of an information system including the intelligent respiratory mask of FIG.1 according to embodiments.

DESCRIPTION OF PREFERRED EMBODIMENTS

FIG.1 illustrates an intelligent respiratory mask **1** integral with an electronic system. Referring to FIG.9, the electronic system is powered up by a battery **29** and comprises, as part of the electronic mask devices, at least one microcontroller/processor **28** and electronics memory **18**. The intelligent respiratory mask **1** may also comprise a communication interface **31**, a pressure sensor **21**, a temperature sensor **22**, a humidity sensor **23**, a microphone **27**, infrared sensor **24**, air flow sensor **25**, touch sensor **26**, speaker **33** and a plurality of lights **32**.

The microcontroller **28** inside the electronics device acts as the central processing unit to process mask information **19** and control the system of electronic circuitry of the device.

The electronic system of the intelligent respiratory mask includes the necessary electronics, software, memory, storage, data bases, firmware, logic/state machines, microprocessors, communication links, and any other input/output interfaces to perform the functions described herein and/or to achieve the results described herein. For example, the electronic system, speaker and air filtering pump system may include one or more processors and memory, such as the microcontroller and electronic memory, which may include system memory, including random access memory (RAM) and read-only memory (ROM). Suitable computer program code may be provided to the electronic system for executing numerous functions, including those discussed in connection with the pressure sensor, temperature sensor, humidity sensor, microphone and plurality of lights indication and the notification system **30**.

For example, in some embodiments, the described sensing elements and notification system include a plurality of computer readable instructions stored in the electronic memory that may be executed and/or accessed by microcontroller. In other embodiments, the systems may be stored remotely and executed and/or accessed via one or more remote computing devices, such as a server over a network, as should be understood by those skilled in the art. The one or more processors, such as the microcontroller, may include one or more conventional microprocessors and may also include one or more supplementary co-processors such as math co-processors or the like. The one or more processors may be configured to communicate with other networks and/or devices such as servers, other processors, computers, cellular telephones, tablets and the like. The one or more processors, including the microcontroller, may be in communication with the electronic memory, which may comprise magnetic, optical and/or semiconductor memory, such as, random access memory (RAM), read only memory (ROM), flash memory, optical memory, or a hard disk drive memory. Electronic memory may store the mask information for use by the electronic device. The memory may also store any other information typically found in computing devices, including an operating system, and/or one or more other programs (e.g., computer program code) that are stored in a non-transitory memory portion and adapted to direct the electronic system to perform according to the various embodiments discussed herein. The data and voice information and/or other programs may be stored, for example, in a compressed format, an uncompiled and/or an encrypted format, and may include computer program code executable by the one or more processors, such as the

microcontroller. The executable instructions of the computer program code may be read into a main memory, such as electronic memory, of the one or more processors, such as the microcontroller, from a non-transitory computer-readable medium other than the electronic memory. While execution of sequences of instructions in the program causes the one or more processors to perform the process steps described herein, hard wired circuitry may be used in place of, or in combination with, executable software instructions for implementation of the processes of the present invention. Thus, embodiments of the present invention are not limited to any specific combination of hardware and software.

For example, the methods and programs discussed herein may also be implemented in programmable hardware devices such as field programmable gate arrays, programable array logic, programmable logic devices or the like. Programs may also be implemented in software

for execution by various types of computer processors. A program of executable code may, for instance, comprise one or more physical or logical blocks of computer instructions, which may, for instance, be organized as an object, procedure, process or function. Nevertheless, the executables of an identified program need not be physically located together, but may comprise separate instructions stored in different locations which, when joined logically together, comprise the program and achieve the stated purpose for the programs such as providing workflow analysis. In an embodiment, an application of executable code may be a compilation of many instructions, which may be distributed over several different code partitions or segments, among different programs, and across several devices. The term “computer-readable medium” as used herein refers to any medium that provides or participates in providing instructions and/or data to the one or more processors of the electronic system (or any other processor of a device described herein) for execution. Such a medium may take many forms, including but not limited to, non-volatile media or memory and volatile memory. Non-volatile memory may include, for example, optical, magnetic, or opto-magnetic disks, or other non-transitory memory. Volatile memory may include dynamic random-access memory (DRAM), which typically constitutes the main memory or other transitory memory.

Referring to FIG.1, the intelligent respiratory mask **1** joins to a translucent soft silicon interfacing **2**, magnetic buckles **12** and electronic device. FIG.2 illustrates the mask consists of a plurality of buttons to enable user interaction with the system includes a power ON **3** the devices, mode selection and speaker sound level **4** adjustment. As seen in FIG.3, A transparent plastic hard cover **6** joints with a translucent soft silicon **2** material interface with facial contours form the integral part of the intelligent respiratory mask. The respiratory mask consists a speaker **5** attach on the mask for voice amplification.

The data and voice information from the mask may be communicated to the paired mobile device **13** wirelessly through the communication interface, shown in FIG. 6, which may include short-range Bluetooth communication protocol, WIFI or any form of radio frequency protocol to form an unitary system.

FIG.4 shows the intelligent respiratory mask **1** with one-directional air valve **8** wherein the valve comprising a shutter to close or open-air flow. The air valve allows air to flow in outward direction from the cavity of the mask. Sliding cover **9** enables users to turn ON or OFF

the function of the valve. The nanometer mesh-structured air filtering materials **7** are attached on two sides of the masks covers which allow the air flow into and out from the mask cavity.

FIG.5 illustrates the mask integrated with electronic circuitry module **10** which comprising a battery **29**, a microcontroller **28**, an electronics memory **18** and plurality of sensors **20** which further consisting a pressure sensor **21**, a temperature sensor **22**, an infrared sensor **24**, air flow sensor **25**, touch sensor **26** and a humidity sensor **23**. The electronic module comprises an attachment mechanism **11** to allow ease of attachment or detachment from the mask cover. The information from the sensor is transmitted through the communication interface to the paired mobile device **13** wirelessly. Shown in FIG.6, the respiratory mask **1** is further comprising with at least one string with magnetic buckles **12** to provide ease of wearing on and taking off the mask.

FIG.7 shows the feeding tubes of the filtered air into and extracting exhaled air out from the mask cavity enabled by the electronic air filtering pump module **16** located in proximity through air tubes **14**. The electronic air filtering pump consist of nanometer mesh-structured air filtering materials **15** to filter out airborne fine particles, **microbial** such as **virus, bacteria etc.** The air filtering pump module may also comprise a communication interface, include short-range Bluetooth communication protocol, WIFI or any form of radio frequency protocol. The filtering pump module is wirelessly turned ON or OFF to feed filtered air into and extract exhaled air out from the mask cavity controlled by the mobile device or intelligent respiratory mask itself. The information from the filtering pump module can be further interacted and notified to owner's paired mobile device **13** or intelligent mask wirelessly through the communication interface. As seen in FIG.10, the extracted information from the intelligent respiratory mask **36** can be further store in cloud system **34** through network connection with an application software being executed by the external mobile device **35**.

FIG.8 illustrates the intelligent respiratory mask **1** pairing with an external Bluetooth speaker device **17**. The user's voice is transmitted wirelessly to the paired Bluetooth speaker devices in proximity for voice amplification.

The invention has been described with reference to the illustration of preferred embodiments described herein. The invention is not unduly limited by this disclosure of the preferred embodiments described. Instead, it is the intended that the invention be defined and their equivalents, set forth in the following claims:

CLAIMS

1. An intelligent mask comprising:

A transparent plastic hard cover joins with a translucent soft silicon material interface with facial contours;

a plurality of nanometer mesh-structured air filtering materials;

a pressure sensor;

a temperature sensor;

a humidity sensor;

a microphone;

a plurality of lights;

a processor in communication with said sensors. The processor adapts to receive signals from said sensors and microphone to detect inhaling and exhaling breathing air activities within mask's cavity and to activate a plurality of air pumps located in proximity to feed filtered air into and extract out air from the mask cavity;

a processor adapted to receive signals from said sensors and microphone and wirelessly paired to proximity devices and remote devices interconnecting to internet, in response to signals from the said sensors and microphone;

a communication interface; and

a computer readable medium coupled to the processor, the computer readable medium including a plurality of instructions stored thereon which, when executed by the processor, cause the processor to perform operations comprising:

wirelessly turning on or off at least one electronic air filtering pump module located in proximity to feed filtered air into and extract exhaled air out from the mask cavity;

regulating the air volume within the mask cavity in accordance to breathing patterns, air flow directions, temperature, humidity and voice activities detected by said sensors and microphone;

pairing and driving at least one wired and one wireless speaker in proximity with the intelligent mask,

turning on or off and adjusting a speaker sound volume picked up by said microphone attached to the mask;

initiating triggers to paired mobile devices in proximity to generate notifications, record and store voice signals picked up by said microphone;

communicating wirelessly with external mobile devices paired with the electronic filtering pump module through a communication interface software

application, the external mobile devices being external to the intelligent mask and in proximity connected to internet thereto, and

wherein the processor, computer readable medium and associated electronic circuits fit into the physical structure of the intelligent mask and interact with the external mobile devices in proximity and wirelessly interconnecting with the electronic air filtering pump module and intelligent mask to form a unitary system.

2. The intelligent mask of claim 1, further comprising an air flow sensor.
3. The intelligent mask of claim 1, further comprising at least one touch sensors.
4. The intelligent mask of claim 1, further comprising at least one switch.
5. The intelligent mask of claim 1, further comprising at least one directional air valve wherein each valve comprising a shutter to close or open air flow.
6. The intelligent mask of claim 1, further comprising an infrared sensor.
7. The intelligent mask of claim 1, further comprising at least a wireless Bluetooth speaker.
8. The intelligent mask of claim 1, further comprising an attachment mechanism to allow electronic sensors with speaker module easily detached to aid sanitization of the mask.
9. The intelligent mask of claim 1, further comprising at least one string with magnetic buckles.
10. The intelligent mask of claim 1, further comprising firmware to interact with mobile devices in proximity and electronic air filtering module in proximity.
11. The intelligent mask of claim 1, further comprising at least a battery to power the intelligent mask.
12. The intelligent mask of claim 1, wherein the communication interface includes at least a short-range wireless Bluetooth communication device.
13. The intelligent mask of claim 1, wherein the communication interface includes at least a short-range wireless WIFI communication device.
14. The intelligent mask of claim 1, wherein the external devices that are wirelessly paired through the communication interface include at least one external mobile device and one electronic air filtering module; and

wherein the processor, computer readable medium and associated electronic circuits are configured to interact in conjunction with the at least one external mobile device through a network link to cloud storage to form an efficient and secured intelligent mask system.

15. An electronically controlled air filtering method comprising:
 - a housing that includes a battery compartment;
 - a plurality layers of nanometer mesh-structured air filtering materials;
 - at least one miniature air pump;
 - at least one miniature air tube in proximity length;
 - a pressure sensor;
 - a temperature sensor;
 - a humidity sensor;

a processor in communication with the intelligent mask of claim 1. The processor adapts to receive signals to activate a plurality of air pumps to regulate the appropriate amount of filtered air channeled into and out from the mask cavity through air tubes;

a communication interface; and

a computer readable medium coupled to the processor, the computer readable medium including a plurality of instructions stored thereon which, when executed by the processor, cause the processor to perform operations comprising:

a processor adapted to receive signals from at least one proximity mobile device prior to wirelessly paired, to activate a plurality of air pumps to channel appropriate amount of filtered air through connected air tubes;

turning on or off at least one air filtering pump;

generating notifications to paired mobile device in response to signals from the sensors;