biological sound data of the entire interval, biological sound generation intervals are specified. FIGS. 9(a) and 9(c) additionally show a biological sound generation interval extracted in this manner.

[0073] Next, with respect to the airflow pressure data, the control part 313 extracts, as an apneic interval, each interval that has a value less than or equal to a threshold that is set in consideration of noise (S203). Accordingly, with respect to the airflow pressure data of the entire interval, apneic intervals are set. FIG. 9(b) additionally shows an apneic interval extracted in this manner.

[0074] Next, in each biological sound generation interval, the control part 313 creates a mel-frequency spectrogram as shown in FIG. 10(b), from the spectrogram created in S202 (S204). In FIG. 10(b), the vertical axis is expressed in the mel-scale. Thus, in the mel-frequency spectrogram shown in FIG. 10(b), compared with the frequency spectrogram shown in FIG. 10(a), the coordinate axis in low frequency bands is extended, and the coordinate axis in high frequency bands is compressed. Accordingly, the resolving power for high frequency bands of the spectrogram is enhanced.

[0075] Next, in each biological sound generation interval, the control part 313 performs continuous wavelet transform on the data obtained in S202 that has been subjected to the short-time Fourier transform, to convert the data into pulses (S205), thereby to generate the pulses as shown in FIG. 10(c). In the

[0120] In Modification 2, among biological sound generation intervals, only biological sound generation intervals that each include an apneic interval longer than or equal to a predetermined period are targeted for swallowing estimation. Accordingly, calculation load can be reduced, and swallowing estimation can be more efficiently performed.

[0121] <Modification 3>

In Modification 3, the control part 313 compares biological sound data in the respiratory phase immediately before each swallowing sound generation interval with biological sound data in the respiratory phase immediately after the swallowing sound generation interval, thereby determining whether aspiration has occurred in the swallowing sound generation interval.

[0122] With reference to the left part of FIG. 15, the control part 313 performs Fourier transform on biological sound data in the inspiratory phase immediately before a swallowing sound generation interval and takes the integral from frequency F1 to frequency F2, thereby calculating a value A. Further, the control part 313 performs Fourier transform on biological sound data in the expiratory phase immediately before the swallowing sound generation interval and takes the integral from frequency F1 to frequency F2, thereby calculating a value B. Similarly, the control part 313 performs Fourier transform on biological sound data in the inspiratory phase immediately after the swallowing sound generation interval and takes the integral from

the information processing device 300 over a wired or wireless communication network. Further, the terminal device 210 may have the function of the information processing device 300 and the information processing device 300 may be omitted. In this case, the control part 214 of the terminal device 210 performs all the processes performed by the information processing device shown in FIGS. 6 to 8, and outputs screens and the like showing results to the display part 211.

[0127] In addition to the above, various modifications can be made as appropriate, without departing from the scope of the technical idea defined by the claims.

[0128] From the embodiments above, an invention according to the claim below can also be derived. In this invention, parameters used in swallowing estimation are not limited to the parameters presented in the embodiments above. One or more of the parameters above can be combined together. Alternatively, other parameters can also be used. This claim can have claims 8 and 9 dependent therefrom.

[0129] <Claim>

A swallowing estimation device comprising:

a sound detection part configured to detect sound of a larynx portion;

a storage part in which sound information outputted from the sound detection part is stored;

a swallowing estimation part configured to estimate

CLAIMS

[Claim 1] A swallowing estimation device comprising:

a sound detection part configured to detect sound of a larynx portion;

a respiration detection part configured to detect respiration;

a swallowing estimation part configured to estimate swallowing based on sound information outputted from the sound detection part and based on respiration information outputted from the respiration detection part;

a storage part in which the sound information outputted from the sound detection part is stored;

an input part capable of designating a timing at which the swallowing estimation part has estimated that swallowing had occurred; and

an output part configured to output information based on a result of the estimation performed by the swallowing estimation part, wherein

the swallowing estimation part obtains a value of a parameter for swallowing estimation with respect to a biological sound generation interval that corresponds to an apneic interval longer than or equal to 400 msec, and estimates whether swallowing has occurred in the biological sound generation interval based on whether the obtained value of the parameter

satisfies a swallowing determination condition, and

the output part obtains from the storage part the sound information having a time width including the timing designated via the input part, and outputs, to outside, sound that is obtained by reproducing the obtained sound information.

[Claim 2] The swallowing estimation device according to claim 1, wherein

as the value of the parameter for the swallowing estimation, the swallowing estimation part obtains, through calculation, a value of a parameter indicating intermittency and continuity of the sound.

[Claim 3] The swallowing estimation device according to claim 2, wherein

the swallowing estimation part obtains a pulse signal by performing calculation processing of Fourier transform and wavelet transform on the sound information, and obtains the number and a length of the obtained pulse signal as the value of the parameter.

[Claim 4] The swallowing estimation device according to any one of claims 1 to 3, wherein

the swallowing estimation part calculates a proportion of sound having a frequency band exceeding a predetermined

frequency in the biological sound generation interval, and estimates whether swallowing has occurred in the biological sound generation interval, using as a further estimation condition whether the calculated proportion exceeds a threshold.

[Claim 5] The swallowing estimation device according to any one of claims 1 to 4, further comprising

a displacement detection part configured to detect displacement of the larynx portion, wherein

using as a further estimation condition whether an amount of the displacement of the larynx portion detected by the displacement detection part in the biological sound generation interval exceeds a threshold, the swallowing estimation part estimates whether swallowing has occurred in the biological sound generation interval.

[Claim 6] The swallowing estimation device according to any one of claims 1 to 5, wherein

the output part displays a screen in which the timing at which it has been estimated that swallowing had occurred is superposed on a time axis, and

the input part is configured to be capable of designating the timing displayed in the screen.

[Claim 7] The swallowing estimation device according to claim 6, wherein

the output part displays, along with the timing, a sound waveform based on the sound information so as to be superposed on the time axis.

[Claim 8] The swallowing estimation device according to any one of claims 1 to 7, wherein

the swallowing estimation part detects, from the respiration information, respiratory phases before and after the timing at which the swallowing estimation part has estimated that swallowing had occurred, and evaluates whether there has been a possibility of aspiration at the timing based on the detected respiratory phases, and

the output part outputs information based on a result of the evaluation performed by the swallowing estimation part.

[Claim 9] The swallowing estimation device according to any one of claims 1 to 8, wherein

the swallowing estimation part detects, from the sound information, inspiration sound and expiration sound before and after the timing at which the swallowing estimation part has estimated that swallowing had occurred, and evaluates whether there has been a possibility of aspiration at the timing based on the detected inspiration sound and expiration sound, and

the output part outputs information based on a result of the evaluation performed by the swallowing estimation part.

[Claim 10] A swallowing estimation device comprising:

a biological sound detection means configured to detect biological sound at a larynx portion;

respiration detection means configured to detect change in airflow of respiration;

a signal intensity conversion means configured to convert biological sound data obtained by sampling the biological sound into signal intensity data;

signal interval identification means configured to identify a signal interval having an intensity level higher than or equal to a noise level based on the signal intensity data;

respiration identification means configured to identify an apneic interval based on airflow pressure data obtained by sampling change in the respiration;

signal pulsing means configured to obtain a signal intensity that corresponds to a sampling timing in the apneic interval that is longer than or equal to a predetermined period and that overlaps the signal interval, and configured to generate a signal pulse having a width that corresponds to a period in which the signal intensity is greater than or equal to a predetermined level;

swallowing reflex estimation means configured to

estimate, as an estimated swallowing reflex interval, the apneic interval that satisfies a determination condition that the number of the signal pulses in the apneic interval longer than or equal to the predetermined period is less than or equal to a predetermined number and a width of each signal pulse in the apneic interval longer than or equal to the predetermined period is less than or equal to a predetermined period; and

display means configured to display the estimated swallowing reflex interval.