

CLAIMS

[Claim 1] A swallowing diagnosis apparatus 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 that swallowing has occurred, on the basis of matching realized between a biogenic sound generation interval for which a feature quantity satisfying a swallowing estimation condition has been obtained in sound information outputted from the sound detection part, and an apneic interval for which respiration has not been detected for longer than or equal to a predetermined time in respiration information outputted from the respiration detection part;

 a first swallowing determination part configured to detect, from the respiration information, respiratory phases before and after a period in which swallowing has been estimated as having occurred by the swallowing estimation part, and

 determine whether or not there is an aspiration risk in the swallowing on the basis of the detected respiratory phases;

 a second swallowing determination part configured to

extract reference information including at least one of the sound information and the respiration information in a predetermined period including the period in which swallowing has been estimated as having occurred by the swallowing estimation part,

obtain a feature quantity from the extracted reference information, and

perform a machine learning process on the obtained feature quantity to determine whether or not there is a possibility of dysphagia in the swallowing; and

a display control part configured to cause a display to display, in a contrastable manner, a determination result obtained by the first swallowing determination part and a determination result obtained by the second swallowing determination part with respect to an identical period in which swallowing has been estimated as having occurred by the swallowing estimation part.

[Claim 2]The swallowing diagnosis apparatus according to claim 1, wherein

the second swallowing determination part extracts the sound information as the reference information, obtains the feature quantity from the extracted sound information, and performs a machine learning process on the obtained feature quantity to determine whether or not there is a possibility of

dysphagia in the swallowing.

[Claim 3]The swallowing diagnosis apparatus according to claim 2, wherein

the second swallowing determination part further extracts the respiration information as the reference information, obtains a feature quantity from the extracted respiration information, and performs a machine learning process on the feature quantity obtained from the respiration information and the feature quantity obtained from the sound information, to determine whether or not there is a possibility of dysphagia in the swallowing.

[Claim 4]The swallowing diagnosis apparatus according to claim 3, further comprising

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

the second swallowing determination part further extracts, as the reference information, displacement information outputted from the displacement detection part in the predetermined period including the period in which swallowing has been estimated as having occurred; obtains a feature quantity from the extracted displacement information; and performs a machine learning process on the feature quantity obtained from the displacement information and the feature

quantities respectively obtained from the sound information and the respiration information, to determine whether or not there is a possibility of dysphagia in the swallowing.

[Claim 5]The swallowing diagnosis apparatus according to claim 4, wherein

when the biogenic sound generation interval and the apneic interval match each other and an amplitude of the displacement information exceeds a predetermined threshold in the biogenic sound generation interval, the swallowing estimation part estimates that swallowing has occurred.

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

the second swallowing determination part subjects the reference information to Fourier transform to obtain a frequency spectrum, applies linear predictive coding to the obtained frequency spectrum to obtain a spectrum envelope, and samples the obtained spectrum envelope at a predetermined frequency interval, thereby obtaining the feature quantity.

[Claim 7]The swallowing diagnosis apparatus according to claim 6, wherein

the second swallowing determination part divides the frequency spectrum for each predetermined frequency band,

applies linear predictive coding for each frequency band to obtain a spectrum envelope, samples the obtained spectrum envelope of each frequency band at a predetermined frequency interval, thereby obtaining the feature quantity.

[Claim 8] The swallowing diagnosis apparatus according to any one of claims 1 to 5, wherein

the second swallowing determination part subjects the reference information to Fourier transform to obtain a frequency spectrum, applies linear predictive coding to the obtained frequency spectrum to obtain a coefficient at each order in the linear predictive coding, and obtains a group of the obtained coefficients, as the feature quantity.

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

the machine learning process is a support vector machine.

[Claim 10] A swallowing diagnosis apparatus 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

that swallowing has occurred, on the basis of matching realized between a biogenic sound generation interval for which a feature quantity satisfying a swallowing estimation condition has been obtained in sound information outputted from the sound detection part, and an apneic interval for which respiration has not been detected for longer than or equal to a predetermined time in respiration information outputted from the respiration detection part; and

a swallowing determination part configured to

extract reference information including at least one of the sound information and the respiration information in a predetermined period including a period in which swallowing has been estimated as having occurred by the swallowing estimation part,

subject the extracted reference information to Fourier transform to obtain a frequency spectrum,

apply linear predictive coding to the obtained frequency spectrum to obtain a spectrum envelope,

sample the obtained spectrum envelope at a predetermined frequency interval to obtain a feature quantity, and

perform a machine learning process on the obtained feature quantity to determine whether or not there is a possibility of dysphagia in the swallowing.

[Claim 11] A program configured to cause a computer of a swallowing diagnosis apparatus which includes: a sound detection part configured to detect sound of a larynx portion; and a respiration detection part configured to detect respiration, to perform:

a swallowing estimation function of estimating that swallowing has occurred, on the basis of matching realized between a biogenic sound generation interval for which a feature quantity satisfying a swallowing estimation condition has been obtained in sound information outputted from the sound detection part, and an apneic interval for which respiration has not been detected for longer than or equal to a predetermined time in respiration information outputted from the respiration detection part;

a first swallowing determination function of detecting, from the respiration information, respiratory phases before and after a period in which swallowing has been estimated as having occurred by the swallowing estimation function, and

determining whether or not there is an aspiration risk in the swallowing on the basis of the detected respiratory phases;

a second swallowing determination function of extracting reference information including at least one of the sound information and the respiration information in

a predetermined period including the period in which swallowing has been estimated as having occurred by the swallowing estimation function,

obtaining a feature quantity from the extracted reference information, and

performing a machine learning process on the obtained feature quantity to determine whether or not there is a possibility of dysphagia in the swallowing; and

a display control function of causing a display to display, in a contrastable manner, a determination result obtained by the first swallowing determination function and a determination result obtained by the second swallowing determination function with respect to an identical period in which swallowing has been estimated as having occurred by the swallowing estimation function.

[Claim 12] The program according to claim 11, wherein

the second swallowing determination function extracts the sound information as the reference information, obtains the feature quantity from the extracted sound information, and performs a machine learning process on the obtained feature quantity to determine whether or not there is a possibility of dysphagia in the swallowing.

[Claim 13] The program according to claim 12, wherein

the second swallowing determination function further extracts the respiration information as the reference information, obtains a feature quantity from the extracted respiration information, and performs a machine learning process on the feature quantity obtained from the respiration information and the feature quantity obtained from the sound information, to determine whether or not there is a possibility of dysphagia in the swallowing.

[Claim 14] The program according to claim 13, wherein

the swallowing diagnosis apparatus further includes a displacement detection part configured to detect displacement of the larynx portion, and

the second swallowing determination function further extracts, as the reference information, displacement information outputted from the displacement detection part in the predetermined period including the period in which swallowing has been estimated as having occurred; obtains a feature quantity from the extracted displacement information; and performs a machine learning process on the feature quantity obtained from the displacement information and the feature quantities respectively obtained from the sound information and the respiration information, to determine whether or not there is a possibility of dysphagia in the swallowing.

[Claim 15] The program according to claim 14, wherein

when the biogenic sound generation interval and the apneic interval match each other and an amplitude of the displacement information exceeds a predetermined threshold in the biogenic sound generation interval, the swallowing estimation function estimates that swallowing has occurred.

[Claim 16] The program according to any one of claims 11 to 15, wherein

the second swallowing determination function subjects the reference information to Fourier transform to obtain a frequency spectrum, applies linear predictive coding to the obtained frequency spectrum to obtain a spectrum envelope, and samples the obtained spectrum envelope at a predetermined frequency interval, thereby obtaining the feature quantity.

[Claim 17] The program according to claim 16, wherein

the second swallowing determination function divides the frequency spectrum for each predetermined frequency band, applies linear predictive coding for each frequency band to obtain a spectrum envelope, and samples the obtained spectrum envelope of each frequency band at a predetermined frequency interval, thereby obtaining the feature quantity.

[Claim 18] The program according to any one of claims 11 to 15, wherein

the second swallowing determination function subjects the reference information to Fourier transform to obtain a frequency spectrum, applies linear predictive coding to the obtained frequency spectrum to obtain a coefficient at each order in the linear predictive coding, and obtains a group of the obtained coefficients, as the feature quantity.

[Claim 19] The program according to any one of claims 11 to 18, wherein

the machine learning process is a support vector machine.