[DESCRIPTION]

[Title of Invention] ACOUSTIC SIGNAL PROCESSING METHOD, INFORMATION GENERATION METHOD, AND ACOUSTIC SIGNAL PROCESSING DEVICE

[Technical Field]

[0001]

The present disclosure relates to an acoustic signal processing method, etc.

[Background Art]

[0002]

Patent Literature (PTL) 1 discloses a technique related to a three-dimensional acoustic calculation method that is an acoustic signal processing method. In this acoustic signal processing method, the loudness (sound pressure) is controlled so as to change inversely proportional to the distance between the sound source and the listener (observer).

[Citation List]

[Patent Literature]

[0003]

[PTL 1] Japanese Unexamined Patent Application Publication No. 2013-201577

[PTL 2] International Patent Application Publication No. 2021/180938

[Non Patent Literature]

[0004]

[NPL 1] Akiyoshi Iida, Physics of Aerodynamic Noise 4 Pseudo Sound Waves and Far Field [online], [retrieved on June 21, 2023], Internet (URL: https://fluid.mech.kogakuin.ac.jp/~iida/Lectures/master/aeroacoustic.pdf)

[NPL 2] The Society of Heating, Air-Conditioning and Sanitary Engineers of Japan, Practical Knowledge for Planning and Designing Air Conditioning Systems (4th Revised Edition), Ohmsha, Ltd., March 24, 2017, p236

[NPL 3] Yoshinori Dobashi, et al., Real-time rendering of

[CLAIMS]

[Claim 1]

An acoustic signal processing method comprising:

obtaining object information and second position information, the object information including first position information indicating a position of an object in a virtual space, first sound data indicating a first sound caused by the object, and first identification information indicating a processing method for the first sound data, the second position information indicating a position of a listener of the first sound in the virtual space;

calculating a distance between the object and the listener based on the first position information included in the object information obtained and the second position information obtained;

determining, based on the first identification information included in the object information obtained, a processing method among a first processing method and a second processing method to use to process the first sound data, the first processing method for processing a loudness according to the distance calculated, the second processing method for processing the loudness according to the distance calculated in a manner different from the first processing method;

processing the first sound data using the processing method determined; and

outputting the first sound data processed.

[Claim 2]

The acoustic signal processing method according to claim 1, wherein

the first processing method is for processing the first sound data to attenuate the loudness inversely proportional with respect to an increase in the distance calculated, and

the second processing method is for processing the first sound data to increase or decrease the loudness in a manner different from the first processing method as the distance calculated increases.

[Claim 3]

The acoustic signal processing method according to claim 2, wherein

the second processing method is for processing the first sound data to attenuate the loudness according to an x-th power of the distance, where $x \neq 1$.

[Claim 4]

The acoustic signal processing method according to claim 3, wherein

the first identification information indicates that the processing method for the first sound data is the second processing method, and indicates a value of x.

[Claim 5]

An information generation method comprising:

obtaining first sound data and first position information, the first sound data indicating a first sound, the first position information indicating a position of an object in a virtual space; and

generating, from the first sound data obtained and the first position information obtained, first object audio information including (i) information related to the object that reproduces the first sound generated at a position of a listener due to the object, and (ii) the first position information.

[Claim 6]

The information generation method according to claim 5, wherein

the object radiates wind,

the listener is exposed to the wind radiated, and

the first sound is an aerodynamic sound generated by the wind radiated from the object reaching an ear of the listener.

[Claim 7]

The information generation method according to claim 6,

wherein

the generating includes generating the first object audio information further including unit distance information, and

the unit distance information includes a unit distance serving as a reference distance, and aerodynamic sound data indicating the aerodynamic sound at a position separated by the unit distance from the position of the object.

[Claim 8]

The information generation method according to claim 7, wherein

the generating includes generating the first object audio information further including directivity information,

the directivity information indicates a characteristic according to a direction of the wind radiated, and

the aerodynamic sound data indicated in the unit distance information is data indicating the aerodynamic sound at a position separated by the unit distance from the position of the object, in a forward direction in which the object radiates the wind as indicated in the directivity information.

[Claim 9]

The information generation method according to claim 5, wherein

the generating includes generating the first object audio information further including flag information indicating whether to, when reproducing the first sound, perform processing to convolve a head-related transfer function that depends on a direction of arrival of sound, on a first sound signal that is based on the first sound data indicating the first sound generated from the object.

[Claim 10]

An information generation method comprising:

obtaining a generation position of a first wind blowing in a virtual space, a first wind direction of the first wind, and a first

assumed wind speed which is a speed of the first wind;

generating fourth object audio information in which the generation position, the first wind direction, and the first assumed wind speed obtained are associated;

storing aerodynamic sound core information including a representative wind speed and aerodynamic sound data indicating aerodynamic sound generated by wind blowing at the representative wind speed reaching an ear of a listener in the virtual space; and

outputting the fourth object audio information generated and the aerodynamic sound core information stored.

[Claim 11]

The information generation method according to claim 10, wherein

the first assumed wind speed is a speed of the first wind at a position separated by a unit distance, serving as a reference distance, from the generation position in the first wind direction.

[Claim 12]

The information generation method according to claim 11, further including:

receiving an operation from a user specifying directivity information indicating a characteristic according to a direction of the first wind, wherein

the generating includes generating the fourth object audio information in which the generation position, the first wind direction, and the first assumed wind speed obtained are associated with the directivity information indicated by the operation received.

[Claim 13]

An acoustic signal processing method comprising:

obtaining the fourth object audio information and the aerodynamic sound core information output by the information generation method according to claim 11 or 12, and second position information indicating a position of the listener in the virtual space;

calculating, based on the generation position included in the fourth object audio information obtained and the second position information obtained, a distance between the generation position and the listener;

processing the aerodynamic sound data to attenuate a loudness of the aerodynamic sound as the distance calculated increases; and

outputting the aerodynamic sound data processed.

[Claim 14]

The acoustic signal processing method according to claim 13, wherein

the processing includes processing the aerodynamic sound data based on an ear-reaching wind speed, the ear-reaching wind speed being a speed of the first wind upon reaching the ear of the listener, and

the ear-reaching wind speed decreases as the distance calculated increases.

[Claim 15]

The acoustic signal processing method according to claim 14, wherein

the ear-reaching wind speed is a value that attenuates according to a z-th power of a value obtained by dividing the distance calculated by the unit distance.

[Claim 16]

An acoustic signal processing method comprising:

obtaining the fourth object audio information and the aerodynamic sound core information output by the information generation method according to claim 11 or 12, and second position information indicating a position of the listener in the virtual space, the aerodynamic sound core information including data indicating a distribution of frequency components of the aerodynamic sound;

calculating, based on the generation position included in the

fourth object audio information obtained and the second position information obtained, a distance between the generation position and the listener;

processing the aerodynamic sound data to shift the distribution of the frequency components of the aerodynamic sound toward lower frequencies as the distance calculated increases; and

outputting the aerodynamic sound data processed.

[Claim 17]

The acoustic signal processing method according to claim 16, wherein

the processing includes processing the aerodynamic sound data based on an ear-reaching wind speed, the ear-reaching wind speed being a speed of the first wind upon reaching the ear of the listener, and

the ear-reaching wind speed decreases as the distance calculated increases.

[Claim 18]

The acoustic signal processing method according to claim 17, wherein

the ear-reaching wind speed is a value that attenuates according to a z-th power of a value obtained by dividing the distance calculated by the unit distance.

[Claim 19]

An acoustic signal processing device comprising:

a first obtainer that obtains object information and second position information, the object information including first position information indicating a position of an object in a virtual space, first sound data indicating a first sound caused by the object, and first identification information indicating a processing method for the first sound data, the second position information indicating a position of a listener of the first sound in the virtual space;

a first calculator that calculates a distance between the object

and the listener based on the first position information included in the object information obtained and the second position information obtained;

a determiner that determines, based on the first identification information included in the object information obtained, a processing method among a first processing method and a second processing method to use to process the first sound data, the first processing method for processing a loudness according to the distance calculated, the second processing method for processing the loudness according to the distance calculated in a manner different from the first processing method;

a first processor that processes the first sound data using the processing method determined; and

a first outputter that outputs the first sound data processed.