[DESCRIPTION]

[Title of Invention] ACOUSTIC SIGNAL PROCESSING METHOD, INFORMATION GENERATION METHOD, COMPUTER PROGRAM, 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 aerodynamic sound using sound textures based on computational fluid dynamics, ACM Transactions on Graphics, Vol. 22, No. 3, p732-740

[Summary of Invention]

[Technical Problem]
[0005]
With the technique disclosed in PTL 1, it may be difficult to provide a sense of realism to the listener.
[0006]
In view of this, embodiments of the present disclosure provide an acoustic signal processing method capable of providing a listener with a sense of realism.

[Solution to Problem]
[0007]
An acoustic signal processing method according to a first aspect aspect of the present disclosure includes: 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.

[0008]

An information generation method according to a second aspect of the present disclosure includes: obtaining first sound data and first position information, the first sound data indicating a first sound generated at a position related to a position of a listener in a virtual space, the first position information indicating a position of an object in the 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 at the position related to the position of the listener due to the object, and (ii) the first position information.

[0009]

Disclosed herein is an acoustic signal processing method that includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and second position information indicating the position of the listener of the first sound; calculating a distance between the object and the listener based on the first position information included in the first object audio information obtained and the second position information obtained; processing the first sound data to attenuate a loudness of the first sound as the distance calculated increases; and outputting the first sound data processed.

[0010]

Disclosed herein is an acoustic signal processing method according to one aspect of the present disclosure includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and second position information indicating the position of the listener of the first sound; calculating a distance between the object that radiates the wind and the listener based on the first position information included in the first object audio information obtained and the second position information obtained; processing the first sound data to attenuate a loudness of the first sound as the distance

calculated increases; and outputting the first sound data processed.
[0011]

Disclosed herein is an acoustic signal processing method that includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and second position information indicating the position of the listener of the first sound; calculating a distance between the object that radiates the wind and the listener based on the first position information included in the first object audio information obtained and the second position information obtained; when the distance calculated is greater than the unit distance indicated by the unit distance information included in the first object audio information obtained, processing the first sound data to attenuate a loudness of the first sound according to the distance calculated and the unit distance; and outputting the first sound data processed.
[0012]

Disclosed herein is an acoustic signal processing method that includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and second position information indicating the position of the listener of the first sound; calculating a distance between the object that radiates the wind and the listener, and a direction between two points connecting the object and the listener, based on the first position information included in the first object audio information obtained and the second position information obtained; processing the first sound data to: control a loudness of the first sound based on (i) an angle formed between the forward direction and the direction between two points calculated and (ii) the characteristic indicated by the directivity information; and when the distance calculated is greater than the unit distance indicated by the unit distance information included in the first object audio information obtained, attenuate the loudness of the first sound according to the distance calculated and the unit distance; and outputting the first sound data processed.
[0013]

Disclosed herein is an acoustic signal processing method that

includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and second object audio information in which the first position information and second sound data indicating a second sound caused by the object are associated; processing including: not processing a first sound signal that is based on the first sound data obtained with processing to convolve a head-related transfer function that depends on a direction of arrival of sound; and processing a second sound signal that is based on the second sound data indicated by the second object audio information obtained with processing to convolve the head-related transfer function that depends on the direction of arrival of sound; and outputting the first sound signal not processed and the second sound signal processed.
[0014]

Disclosed herein is an acoustic signal processing method that includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and second object audio information in which the first position information and second sound data indicating a second sound caused by the object are associated; processing including: processing a first sound signal that is based on the first sound data obtained with processing dependent on a direction of arrival of wind; and processing a second sound signal that is based on the second sound data indicated by the second object audio information obtained with processing to convolve a head-related transfer function that depends on a direction of arrival of sound; and outputting the first sound signal processed and the second sound signal processed.
[0015]

Disclosed herein is an acoustic signal processing method that includes: obtaining the first object audio information generated by an information generation method described above, the first sound data obtained, and third object audio information in which third position information indicating a position of an other object in the virtual space and third sound data indicating a third sound generated at the position of the other object are associated, the other object being different from the object; processing including: processing a

first sound signal that is based on the first sound data obtained with processing dependent on a direction of arrival of wind; and processing a third sound signal that is based on the third sound data indicated by the third object audio information obtained with processing to convolve a head-related transfer function that depends on a direction of arrival of sound; and outputting the first sound signal processed and the third sound signal processed.

[0016]

An information generation method according to a third aspect of the present disclosure includes: 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.

[0017]

An acoustic signal processing method according to a fourth aspect of the present disclosure includes: obtaining the fourth object audio information and the aerodynamic sound core information output by an information generation method described above, 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.

[0018]

An acoustic signal processing method according to a fifth aspect of the present disclosure includes: obtaining the fourth object

audio information and the aerodynamic sound core information output by an information generation method described above, 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.

[0019]

Disclosed herein is an information generation method that includes: obtaining a second wind direction of a second wind blowing in a virtual space and a second assumed wind speed which is a speed of the second wind; generating fifth object audio information in which the second wind direction and the second 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 fifth object audio information generated and the aerodynamic sound core information stored.

[0020]

Disclosed herein is an information generation method that includes: obtaining a generation position of a first wind blowing in a virtual space, a first wind direction of the first wind, a first assumed wind speed which is a speed of the first wind, a second wind direction of a second wind blowing in the virtual space, and a second assumed wind speed which is a speed of the second wind; generating fourth object audio information in which the generation position, the first wind direction, and the first assumed wind speed obtained are associated, and generating fifth object audio information in which the second wind direction and the second assumed wind speed

obtained are associated; and outputting the fourth object audio information generated and the fifth object audio information generated.

[0021]

Disclosed herein is an acoustic signal processing method that includes: obtaining second position information indicating a position of the listener in the virtual space, and the fourth object audio information or the fifth object audio information output by an information generation method described above; when the fourth object audio information is obtained, processing the aerodynamic sound data included in the aerodynamic sound core information based on the position indicated by the second position information obtained, and when the fifth object audio information is obtained, processing the aerodynamic sound data included in the aerodynamic sound core information irrespective of the position indicated by the second position information obtained; and outputting the aerodynamic sound data processed.

[0022]

Disclosed herein is a computer program for causing a computer to execute an acoustic signal processing method described above.

[0023]

Disclosed herein is a computer program for causing a computer to execute an information generation method described above.

[0024]

An acoustic signal processing device according to a sixth aspect aspect of the present disclosure includes: 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.

[0025]

Note that these general or specific aspects may be implemented using a system, a device, a method, an integrated circuit, a computer program, or a non-transitory computer-readable recording medium such as a CD-ROM, or any combination thereof.

[Advantageous Effects of Invention]

[0026]

An acoustic signal processing method according to embodiments of the present disclosure is capable of providing a listener with a sense of realism.

[Brief Description of Drawings]

[0027]

[FIG. 1]

FIG. 1 is a diagram for explaining a first example of aerodynamic sound (wind noise) generated accompanying the