[CLAIMS]

[Claim 1]

An information processing device comprising:

an obtainer that obtains sound information including an audio signal and information on a position of a sound source object in a three-dimensional sound field;

a first generator that generates an output sound signal using (i) a head-related transfer function corresponding to a direction of arrival and (ii) the audio signal, the direction of arrival being based on the position of the sound source object and a position of a user in the three-dimensional sound field; and

a second generator that generates an output sound signal using (i) a head-related transfer function corresponding to a representative direction and (ii) the audio signal, the representative direction being based on a position of a representative point set in the three-dimensional sound field and the position of the user.

[Claim 2]

The information processing device according to claim 1, wherein

the first generator generates the output sound signal by convolving the head-related transfer function corresponding to the direction of arrival with reproduced sound emitted from the sound source object based on the audio signal, and

the second generator generates the output sound signal by performing conversion processing that converts the reproduced sound into representative sound arriving from the representative point, and convolving the head-related transfer function corresponding to the representative direction.

[Claim 3]

The information processing device according to claim 2, wherein

in the conversion processing, the reproduced sound is converted into the representative sound by applying time shift

adjustment and gain adjustment to the reproduced sound.

[Claim 4]

The information processing device according to claim 3, wherein

in the time shift adjustment in the conversion processing, one of the following is applied to the reproduced sound:

a time shift calculated to maximize a cross-correlation between the head-related transfer function corresponding to the direction of arrival and the head-related transfer function corresponding to the representative direction; or

a time shift with a negative sign added to the time shift calculated.

[Claim 5]

The information processing device according to claim 4, wherein

in the conversion processing, at least one of the time shift adjustment or the gain adjustment applies a time shift calculated to maximize the cross-correlation after applying a frequency-domain weighting filter, or a time shift with a negative sign added to the time shift calculated.

[Claim 6]

The information processing device according to claim 4, wherein

the representative point and the representative direction respectively comprise a plurality of representative points and a plurality of representative directions, and

in the conversion processing, for each of two or more of the plurality of representative points, a gain that is set for the reproduced sound and for each of the plurality of representative directions is applied to the reproduced sound applied with the time shift.

[Claim 7]

The information processing device according to claim 6, wherein

in the conversion processing, when synthesizing a head-related transfer function vector corresponding to the direction of arrival using a sum of head-related transfer function vectors corresponding to the plurality of representative directions, a gain is used that is so calculated that an error signal vector between the head-related transfer function vector synthesized and the head-related transfer function vector corresponding to the direction of arrival is orthogonal to the head-related transfer function vectors corresponding to the plurality of representative directions.

[Claim 8]

The information processing device according to claim 6, wherein

in the conversion processing, a gain is used that is calculated to minimize energy or L2 norm of an error signal vector between a synthesized head-related transfer function vector and a head-related transfer function vector corresponding to the direction of arrival.

[Claim 9]

The information processing device according to claim 8, wherein

the error signal vector is one to which a frequency-domain weighting filter has been applied.

[Claim 10]

The information processing device according to claim 3, wherein

the information processing device stores an adjustment amount table into storage at initialization, the adjustment amount table associating, for each head-related transfer function direction, a head-related transfer function of a representative direction with adjustment amounts for the time shift adjustment and the gain

adjustment to be used in the conversion processing, and

in the conversion processing, the reproduced sound is converted into the representative sound by applying the time shift adjustment and the gain adjustment to the reproduced sound using, from the adjustment amount table stored in the storage, the adjustment amounts associated with each head-related transfer function direction corresponding to the representative direction.

[Claim 11]

The information processing device according to claim 10, wherein

at the initialization, the information processing device determines a plurality of representative directions each of which is the representative direction, and

the adjustment amount table is created based on head-related transfer functions of the plurality of representative directions determined.

[Claim 12]

The information processing device according to claim 1, wherein

the sound information includes a flag that specifies whether to generate the output sound signal using the first generator or to generate the output sound signal using the second generator, and

the information processing device generates the output sound signal using one of the first generator or the second generator that is specified by the flag included in the sound information obtained.

[Claim 13]

The information processing device according to claim 1, further comprising:

a switcher that switches between generating the output sound signal using the first generator or generating the output sound signal using the second generator.

[Claim 14]

The information processing device according to any one of claims 1 to 13, further comprising:

a route calculator that calculates a propagation route of reproduced sound emitted from the sound source object based on the audio signal, and calculates (i) a synthesized sound arriving at the position of the user by indirect propagation of the reproduced sound according to the propagation route of the reproduced sound calculated, and (ii) a direction of arrival of the synthesized sound.

[Claim 15]

An information processing method executed by a computer, the information processing method generating an output sound signal as a sound arriving from a sound source object in a virtual three-dimensional sound field by processing sound information, the information processing method comprising:

obtaining a position of the sound source object and an audio signal including reproduced sound emitted from the sound source object based on the audio signal;

obtaining a position of a user in the three-dimensional sound field;

calculating a direction of arrival of the reproduced sound arriving at the position of the user from the position of the sound source object;

generating the output sound signal using (i) a head-related transfer function corresponding to the direction of arrival calculated and (ii) the reproduced sound; and

generating the output sound signal using (i) a head-related transfer function corresponding to a representative direction and (ii) the audio signal, the representative direction being based on a position of a representative point set in the three-dimensional sound field and the position of the user.

[Claim 16]

A program for causing a computer to execute the information

processing method according to claim 15.

[Claim 17]

An information processing device comprising:

storage that stores a time shift adjustment amount and a gain adjustment amount in association with each of a plurality of directions;

an obtainer that obtains an audio signal and information on a position of a sound source object in a three-dimensional sound field; and

a second generator that generates an output sound signal as sound arriving at a position of a user in the three-dimensional sound field from a second direction, using (i) the audio signal and (ii) the time shift adjustment amount and the gain adjustment amount corresponding to a first direction based on the position of the sound source object and the position of the user.

[Claim 18]

The information processing device according to claim 17, wherein

the storage further stores a head-related transfer function corresponding to the second direction, and

the second generator generates the output sound signal as sound arriving at the position of the user from the second direction using (i) the audio signal, (ii) the time shift adjustment amount and the gain adjustment amount corresponding to the first direction, and (iii) the head-related transfer function corresponding to the second direction.

[Claim 19]

The information processing device according to claim 17, wherein

the storage further stores a head-related transfer function corresponding to the second direction and head-related transfer functions corresponding to directions other than the second

direction,

the second generator generates the output sound signal as sound arriving at the position of the user from the second direction using (i) the audio signal, (ii) the time shift adjustment amount and the gain adjustment amount corresponding to the first direction, and (iii) the head-related transfer function corresponding to the second direction,

the information processing device further comprises a first generator, and

the first generator generates an audio signal as sound arriving at the position of the user from the first direction using (i) the audio signal and (ii) a head-related transfer function corresponding to the first direction.