

INTER-CHANNEL PHASE DIFFERENCE PARAMETER ENCODING METHOD AND APPARATUS

[0001] This application claims priority to Chinese Patent Application No. 201710524352.0, filed with the Chinese Patent Office on June 30, 2017 and entitled
5 "INTER-CHANNEL PHASE DIFFERENCE PARAMETER ENCODING METHOD AND APPARATUS", which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

[0002] The present invention relates to the field of communications technologies, and in particular, to an inter-channel phase difference parameter encoding method and
10 apparatus.

BACKGROUND

[0003] As quality of life is improved, a requirement for high-quality audio is constantly increased. Compared with mono audio, stereo audio presents a sense of orientation and a sense of distribution for each acoustic source, and can improve clarity
15 and intelligibility of audio information and enhance a sense of presence of audio play. Therefore, stereo audio is highly favored by people.

[0004] A parametric stereo (Parametric Stereo, PS) encoding technology is a common stereo encoding technology. In the PS encoding technology, encoding and decoding processing is performed on a stereo signal (in other words, a multi-channel
20 signal) based on a spatial perception characteristic. Specifically, encoding and decoding of a multi-channel signal are converted into encoding and decoding of a mono audio signal and encoding and decoding of spatial perception parameters. The spatial perception parameters in PS encoding include inter-channel correlation (Inter-channel

Correlation, IC), an inter-channel level difference (Inter-channel Level Difference, ILD), an inter-channel time difference (Inter-channel Time Difference, ITD), an inter-channel phase difference (Inter-channel Phase Difference, IPD), and the like. An ITD parameter and an IPD parameter are spatial perception parameters that indicate horizontal orientation of an acoustic source. An ILD parameter, the ITD parameter, and the IPD parameter determine human ear's perception of a location of the acoustic source, and can effectively determine a sound field location and is important for stereo signal restoration. Therefore, determining of parameters such as the IPD parameter is important for stereo signal restoration.

10 **[0005]** In the prior art 1, when an IPD parameter of each frame in a stereo signal is calculated, specifically, a time domain signal is transformed into a frequency domain signal, the frequency domain signal is divided into a plurality of subbands, IPD parameters of subbands are calculated one by one, and then the IPD parameters of all subbands are quantized to be used to encode the stereo signal. It can be learned that, calculation of the IPD parameter in the prior art 1 needs to be performed on the subbands one by one. Consequently, a plurality of resources are occupied, and encoding efficiency is low.

[0006] In the prior art 2, when an IPD parameter of each frame in a stereo signal is calculated, specifically, a time domain signal is transformed into a frequency domain signal, an IPD parameter of a stereo signal with one frame is calculated based on the frequency domain signal. The IPD parameter of the stereo signal with the frame is a group inter-channel phase difference (namely, group IPD) parameter, and then the group IPD parameter is quantized to be used to encode the stereo signal. It can be learned that, in the prior art, only one IPD parameter (that is, the group IPD parameter) is calculated, and then only one IPD parameter can be quantized. Although less resources are occupied, phase information precision for encoding is low, and encoding quality is poor.

SUMMARY

[0007] This application provides an inter-channel phase difference parameter

encoding method and apparatus to increase a diversity of selecting an IPD parameter encoding scheme, better maintain phase information, and improve audio encoding quality.

5 **[0008]** According to a first aspect of the present invention, an inter-channel phase difference parameter encoding method is provided and includes:

obtaining a reference parameter used to determine an inter-channel phase difference IPD parameter encoding scheme of a current frame of a multi-channel signal;

10 determining the IPD parameter encoding scheme of the current frame based on the reference parameter, where the determined IPD parameter encoding scheme of the current frame is one of at least two preset IPD parameter encoding schemes; and

processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame.

15 **[0009]** It can be learned that when the IPD parameter is encoded, the reference parameter is obtained, the IPD parameter encoding scheme of the current frame corresponding to the current frame is determined based on the reference parameter, and the IPD parameter of the current frame is processed by using the determined IPD parameter encoding scheme, so that not only the IPD parameter of the current frame can be adaptively processed, but also processing of the IPD parameter of the current frame matches with the current frame, to improve encoding quality of the multi-channel
20 signal.

25 **[0010]** With reference to the first aspect, in a first implementation of the first aspect, the reference parameter includes at least one of a signal characteristic parameter of the current frame and signal characteristic parameters of A frames previous to the current frame, and A is an integer not less than 1.

30 **[0011]** The signal characteristic parameter of the current frame includes at least one of a parameter indicating correlation between left channel and right channel of the current frame, a variance of subband IPD parameters of the current frame, a signal type of the current frame, and the inter-channel time difference ITD parameter of the current frame.

30 **[0012]** The signal characteristic parameters of the A frames previous to the current

frame include at least one of a parameter indicating correlation between left channel and right channel of each of the previous A frames, a variance of subband IPD parameters of each of the previous A frames, an ITD parameter of each of the previous A frames, an IPD parameter encoding scheme of each of the previous A frames, and a
5 signal type of each of the previous A frames.

[0013] The signal type includes a voice type or a music type.

[0014] A value of A may be 1, 2, 3, 4, 5, or the like.

[0015] It can be learned that, in some cases, when the IPD parameter encoding scheme of the current frame is to be determined, not only the signal characteristic
10 parameter of the current frame is used, but also signal characteristic parameters of the A frames previous to the current frame is used, so that the determined IPD parameter encoding scheme of the current frame not only matches with the current frame but also matches with the A frames previous to the current frame, to ensure continuous continuity of the encoding scheme, and further improve encoding quality.

15 **[0016]** With reference to the first implementation of the first aspect, in a second implementation of the first aspect, the reference parameter includes the parameter indicating the correlation between the left channel and right channel of the current frame.

[0017] If a value of the parameter indicating the correlation between the left channel
20 and right channel of the current frame is greater than or equal to a first threshold, the IPD parameter encoding scheme of the current frame is a first encoding scheme in the at least two IPD parameter encoding schemes.

[0018] With reference to the second implementation of the first aspect, in a third implementation of the first aspect, the first threshold is 0.75.

25 **[0019]** With reference to any one of the first implementation to the third implementation of the first aspect, in a fourth implementation of the first aspect, the reference parameter includes the IPD parameter encoding scheme of each of the previous A frames and the signal type of each of the previous A frames.

[0020] If the IPD parameter encoding scheme of each of the previous A frames is
30 the first encoding scheme in the at least two IPD parameter encoding schemes, and the

signal type of each of the previous A frames is a music type, the IPD parameter encoding scheme of the current frame is the first encoding scheme, and the value of A may be 1.

[0021] With reference to the first implementation of the first aspect, in a fifth implementation of the first aspect, the reference parameter includes the ITD parameter of the current frame, the variance of the subband IPD parameters of the current frame, and the signal type of each of the previous A frames.

[0022] If a value of the ITD parameter of the current frame is greater than a third threshold, the variance of the subband IPD parameters of the current frame is less than a fourth threshold, and the signal type of each of the A frames previous to the current frame is a voice type, the IPD parameter encoding scheme of the current frame is the first encoding scheme in the at least two IPD parameter encoding schemes.

[0023] With reference to any one of the second implementation to the fifth implementation of the first aspect, in a sixth implementation of the first aspect, the first encoding scheme includes any one of the following manners:

a group inter-channel phase difference group IPD parameter encoding scheme;

skipping encoding an IPD parameter; or

setting a value of an IPD parameter to 0.

[0024] In some cases, whether the IPD parameter of the current frame is transmitted to a decoder does not improve a decoding effect. Therefore, the first encoding scheme may be skipping encoding the IPD parameter, setting the value of the IPD parameter to 0, or the group ID parameter encoding scheme. When the first encoding scheme is skipping encoding the IPD parameter, all encoding bits can be used to encode a parameter that can improve a decoding effect. When the first encoding scheme is setting the value of the IPD parameter to 0, or the group ID parameter encoding scheme, because the IPD parameter or a group ID parameter with a value of 0 occupies very few bits, the encoding bits may alternatively be used as many as possible to encode the parameter that can improve the decoding effect, to improve an encoding effect.

[0025] With reference to the sixth implementation of the first aspect, in a seventh implementation of the first aspect, when the first encoding scheme is the group IPD

parameter encoding scheme, the processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame includes:

extracting subband IPD parameters of left channel frequency domain signal and right channel frequency domain signal of the current frame;

5 determining a group IPD parameter of the current frame based on the extracted subband IPD parameters; and

encoding the group IPD parameter of the current frame.

[0026] With reference to any one of the second implementation to the seventh implementation of the first aspect, in an eighth implementation of the first aspect, if the

10 IPD parameter encoding scheme of the current frame is not the first encoding scheme, the IPD parameter encoding scheme of the current frame is a second encoding scheme.

[0027] The second encoding scheme includes an IPD parameter encoding scheme of a subband set, or a subband IPD parameter encoding scheme, and the subband IPD

15 parameter encoding scheme is encoding subband IPD parameters of some or all of subbands of the current frame.

[0028] With reference to the eighth implementation of the first aspect, in a ninth implementation of the first aspect, the second encoding scheme is the subband IPD parameter encoding scheme.

20 **[0029]** The processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame includes:

calculating IPD parameters of all or some of subbands of left channel frequency domain signal and right channel frequency domain signal of the current frame; and

25 encoding the IPD parameters that are of all or some of the subbands and that are obtained through calculation.

[0030] When the second encoding scheme is encoding the IPD parameters of some of the subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame, only subband IPD parameters of some subbands

30 that are at a relatively low frequency and that are of the left channel frequency domain

signal and right channel frequency domain signal of the current frame may be encoded. In an implementation, IPD parameters of remaining subbands different from a subband at the highest frequency and a subband at the second highest frequency may be encoded. Because the subband IPD parameters different from the subband at the highest
5 frequency and the subband at the second highest frequency does not significantly improve an encoding effect, skipping encoding subband IPD parameters of two subbands can ensure that an encoding bit is used for a parameter that can better improve the encoding effect, to further improve encoding quality.

[0031] With reference to any one of the first aspect or the first implementation to
10 the ninth implementation of the first aspect, in a tenth implementation of the first aspect, the method further includes:

performing encoding based on the determined IPD parameter encoding scheme of the current frame.

[0032] For example, an encoding scheme flag bit may be set, and the flag bit
15 occupies one bit, to indicate whether the IPD parameter encoding scheme of the current frame is a first encoding scheme or a second encoding scheme. In this way, a decoder can determine the IPD parameter encoding scheme of the current frame based on the encoding scheme flag bit, to perform decoding by using a corresponding decoding manner.

[0033] With reference to any one of the first aspect or the first implementation to
20 the tenth implementation of the first aspect, in an eleventh implementation of the first aspect, before the processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame, the method further includes:

25 determining whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted;

adjusting the determined IPD parameter encoding scheme of the current frame when it is determined that the determined IPD parameter encoding scheme of the current frame needs to be adjusted.

30 **[0034]** The processing an IPD parameter of the current frame based on the

determined IPD parameter encoding scheme of the current frame includes:

processing the IPD parameter of the current frame based on the adjusted IPD parameter encoding scheme of the current frame.

[0035] With reference to the eleventh implementation of the first aspect, in a twelfth implementation of the first aspect, the determining whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted is performed based on IPD parameter encoding schemes of the A frames previous to the current frame.

[0036] Whether the IPD parameter encoding scheme of the current frame is determined based on the IPD parameter encoding schemes of the A frames previous to the current frame, to ensure a smooth transition between the IPD parameter encoding scheme of the current frame and the IPD parameter encoding schemes of the A frames previous to the current frame, to avoid a sudden change of an encoding effect.

[0037] With reference to any one of the first implementation to the twelfth implementation of the first aspect, in a thirteenth implementation of the first aspect, the parameter indicating the correlation between the left channel and right channel of the current frame is obtained by using the following calculation formula:

$$corr = \sum_{b=0}^N \frac{[E_l(b) + E_r(b) + 2 \times D_r(b)]}{[E_l(b) + E_r(b) + 2\sqrt{D_r^2(b) + D_i^2(b)}]}, \text{ where}$$

$$E_l(b) = \sum_{k=0}^L |L(k)|^2;$$

$$E_r(b) = \sum_{k=0}^L |R(k)|^2;$$

$$D_r(b) = \sum_{k=0}^L [L_r(k) \times R_r(k) + L_i(k) \times R_i(k)];$$

$$D_i(b) = \sum_{k=0}^L [L_i(k) \times R_r(k) - L_r(k) \times R_i(k)];$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) \times e^{-j \frac{2\pi \times n \times k}{L}}, 0 \leq k < L$$

; and

$$R(k) = \sum_{n=0}^{Length-1} x_R(n)xe^{-j\frac{2\pi n x k}{L}}, 0 \leq k < L$$

, where

[0038] $E_l(b)$ indicates an energy sum of an audio-left channel, $E_r(b)$ indicates an energy sum of an audio-right channel, $L_r(k)$ indicates a real part of a k^{th} frequency value of an audio-left channel frequency domain signal, $R_r(k)$ indicates a real part of a k^{th} frequency value of an audio-right channel frequency domain signal, $L_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-left channel frequency domain signal, $R_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-right channel frequency domain signal, L indicates a quantity of subband spectral coefficients, and N indicates a quantity of subbands, n indicates an index value of a time domain signal, k indicates an index value of a frequency domain signal, $Length$ indicates a frame length, $x_L(n)$ indicates an audio-left channel time domain signal, $x_R(n)$ indicates an audio-right channel time domain signal, $L(k)$ indicates a k^{th} frequency value that is of the audio-left channel frequency domain signal and that is used to calculate the IPD parameter, and $R(k)$ indicates a k^{th} frequency value that is of the audio-right channel frequency domain signal and that is used to calculate the IPD parameter, where $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.

[0039] With reference to any one of the first implementation to the twelfth implementation of the first aspect, in a fourteenth implementation of the first aspect, the parameter indicating the correlation between the left channel and right channel of the current frame is obtained by using the following calculation formula:

$$corr = \sum_{i=0}^L \frac{|L(k) + R(k)|^2}{(|L(k)| + |R(k)|)^2}, \text{ where}$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n)xe^{-j\frac{2\pi n x k}{L}}, 0 \leq k < L$$

; and

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L$$

, where

[0040] L indicates a quantity of subband spectral coefficients, n indicates an index value of a time domain signal, k indicates an index value of a frequency domain signal,

Length indicates a frame length, $x_L(n)$ indicates an audio-left channel time

5 domain signal, and $x_R(n)$ indicates an audio-right channel time domain signal,

where $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.

[0041] With reference to any one of the first implementation to the twelfth implementation of the first aspect, in a fifteenth implementation of the first aspect, the parameter indicating the correlation between the left channel and right channel of the

10 current frame is obtained by using the following calculation formula:

$$corr = \frac{\left(\sum_{k=1}^{L/2-1} |L(k)R^*(k)| \right)^2}{\sum_{k=1}^{L/2-1} (|L(k)|)^2 \sum_{k=1}^{L/2-1} (|R(k)|)^2}, \text{ where}$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L$$

; and

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L$$

.

[0042] L indicates a quantity of subband spectral coefficients, n indicates an index value of a time domain signal, k indicates an index value of a frequency domain signal,

Length indicates a frame length, $x_L(n)$ indicates an audio-left channel time

domain signal, and $x_R(n)$ indicates an audio-right channel time domain signal,

where $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers. $R^*(k)$ indicates a

conjugate of $R(k)$. To be specific, $R^*(k)$ indicates a conjugate of a k^{th} frequency

20 value of an audio-right channel frequency domain signal.

[0043] According to a second aspect of the present invention, an inter-channel

phase difference parameter encoding apparatus is provided and includes:

an obtaining unit, configured to obtain a reference parameter, where the reference parameter is used to determine an inter-channel phase difference IPD parameter encoding scheme of a current frame of a multi-channel signal;

5 a determining unit, configured to determine the IPD parameter encoding scheme of the current frame based on the reference parameter, where the determined IPD parameter encoding scheme of the current frame is one of at least two preset IPD parameter encoding schemes; and

a processing unit, configured to process an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame.

[0044] It can be learned that when the IPD parameter is encoded, the reference parameter is obtained, the IPD parameter encoding scheme of the current frame corresponding to the current frame is determined based on the reference parameter, and the IPD parameter of the current frame is processed by using the determined IPD parameter encoding scheme, so that not only the IPD parameter of the current frame can be adaptively processed, but also processing of the IPD parameter of the current frame matches with the current frame, to improve encoding quality of the multi-channel signal.

[0045] With reference to the second aspect, in a first implementation of the second aspect, the reference parameter includes at least one of a signal characteristic parameter of the current frame and signal characteristic parameters of A frames previous to the current frame, and A is an integer not less than 1.

[0046] The signal characteristic parameter of the current frame includes at least one of a parameter indicating correlation between left channel and right channel of the current frame, a variance of subband IPD parameters of the current frame, a signal type of the current frame, and the inter-channel time difference ITD parameter of the current frame.

[0047] The signal characteristic parameters of the A frames previous to the current frame include at least one of a parameter indicating correlation between left channel and right channel of each of the previous A frames, a variance of subband IPD

parameters of each of the previous A frames, an ITD parameter of each of the previous A frames, an IPD parameter encoding scheme of each of the previous A frames, and a signal type of each of the previous A frames.

[0048] The signal type includes a voice type or a music type.

5 **[0049]** It can be learned that, in some cases, when the IPD parameter encoding scheme of the current frame is to be determined, not only the signal characteristic parameter of the current frame is used, but also signal characteristic parameters of the A frames previous to the current frame is used, so that the determined IPD parameter encoding scheme of the current frame not only matches with the current frame but also
10 matches with the A frames previous to the current frame, to ensure continuous continuity of the encoding scheme, and further improve encoding quality.

[0050] With reference to the first implementation of the second aspect, in a second implementation of the second aspect, the reference parameter includes the parameter indicating the correlation between the left channel and right channel of the current
15 frame.

[0051] If a value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to a first threshold, the IPD parameter encoding scheme of the current frame is a first encoding scheme in the at least two IPD parameter encoding schemes.

20 **[0052]** With reference to the second implementation of the second aspect, in a third implementation of the second aspect, the first threshold is 0.75.

[0053] With reference to the first implementation of the second aspect, in a fourth implementation of the second aspect, the reference parameter includes the IPD parameter encoding scheme of each of the previous A frames and the signal type of
25 each of the previous A frames.

[0054] If the IPD parameter encoding scheme of each of the previous A frames is the first encoding scheme in the at least two IPD parameter encoding schemes, and the signal type of each of the previous A frames is a music type, the IPD parameter encoding scheme of the current frame is the first encoding scheme, and the value of A may be 1.

30 **[0055]** With reference to any one of the second implementation to the fourth

implementation of the second aspect, in a fifth implementation of the second aspect, the reference parameter includes the ITD parameter of the current frame, the variance of the subband IPD parameters of the current frame, and the signal type of each of the previous A frames.

5 **[0056]** If a value of the ITD parameter of the current frame is greater than a third threshold, the variance of the subband IPD parameters of the current frame is less than a fourth threshold, and the signal type of each of the A frames previous to the current frame is a voice type, the IPD parameter encoding scheme of the current frame is the first encoding scheme in the at least two IPD parameter encoding schemes.

10 **[0057]** With reference to any one of the second implementation to the fifth implementation of the second aspect, in a sixth implementation of the second aspect, the first encoding scheme includes any one of the following manners:

 a group inter-channel phase difference group IPD parameter encoding scheme;

15 skipping encoding an IPD parameter; or
 setting a value of an IPD parameter to 0.

[0058] In some cases, whether the IPD parameter of the current frame is transmitted to a decoder does not improve a decoding effect. Therefore, the first encoding scheme may be skipping encoding the IPD parameter, setting the value of the IPD parameter to
20 0, or the group ID parameter encoding scheme. When the first encoding scheme is skipping encoding the IPD parameter, all encoding bits can be used to encode a parameter that can improve a decoding effect. When the first encoding scheme is setting the value of the IPD parameter to 0, or the group ID parameter encoding scheme, because the IPD parameter or a group ID parameter with a value of 0 occupies very
25 few bits, the encoding bits may alternatively be used as many as possible to encode the parameter that can improve the decoding effect, to improve an encoding effect.

[0059] With reference to any one of the second implementation to the fifth implementation of the second aspect, in a seventh implementation of the second aspect, if the IPD parameter encoding scheme of the current frame is not the first encoding
30 scheme,

the IPD parameter encoding scheme of the current frame is a second encoding scheme.

[0060] The second encoding scheme includes an IPD parameter encoding scheme of a subband set, or a subband IPD parameter encoding scheme, and the subband IPD parameter encoding scheme is encoding subband IPD parameters of some or all of subbands of the current frame.

[0061] With reference to the seventh implementation of the second aspect, in an eighth implementation of the second aspect, the second encoding scheme is the subband IPD parameter encoding scheme.

10 **[0062]** The processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame includes:

calculating IPD parameters of all or some of subbands of left channel frequency domain signal and right channel frequency domain signal of the current frame; and

15 encoding the IPD parameters that are of all or some of the subbands and that are obtained through calculation.

[0063] When the second encoding scheme is encoding the IPD parameters of some of the subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame, only subband IPD parameters of some subbands that are at a relatively low frequency and that are of the left channel frequency domain signal and right channel frequency domain signal of the current frame may be encoded. In an implementation, IPD parameters of remaining subbands different from a subband at the highest frequency and a subband at the second highest frequency may be encoded. Because the subband IPD parameters different from the subband at the highest frequency and the subband at the second highest frequency does not significantly improve an encoding effect, skipping encoding subband IPD parameters of two subbands can ensure that an encoding bit is used for a parameter that can better improve the encoding effect, to further improve encoding quality.

25 **[0064]** With reference to any one of the second aspect or the first implementation to the eighth implementation of the second aspect, in a ninth implementation of the

second aspect, the apparatus further includes:

an encoding unit, configured to perform encoding based on the determined IPD parameter encoding scheme of the current frame.

[0065] For example, an encoding scheme flag bit may be set, and the flag bit occupies one bit, to indicate whether the IPD parameter encoding scheme of the current frame is a first encoding scheme or a second encoding scheme. In this way, a decoder can determine the IPD parameter encoding scheme of the current frame based on the encoding scheme flag bit, to perform decoding by using a corresponding decoding manner.

[0066] With reference to any one of the second aspect or the first implementation to the ninth implementation of the second aspect, in a tenth implementation of the second aspect, the determining unit is further configured to determine whether the IPD parameter encoding scheme that is of the current frame and that is determined by the determining unit needs to be adjusted.

[0067] The apparatus further includes:

an adjusting unit, configured to adjust the determined IPD parameter encoding scheme of the current frame when the determining unit determines that the determined IPD parameter encoding scheme of the current frame needs to be adjusted; and

the processing unit, further configured to process the IPD parameter of the current frame based on the adjusted IPD parameter encoding scheme of the current frame.

[0068] With reference to the tenth implementation of the second aspect, in an eleventh implementation of the second aspect, the determining whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted is performed based on IPD parameter encoding schemes of the A frames previous to the current frame.

[0069] Whether the IPD parameter encoding scheme of the current frame is determined based on the IPD parameter encoding schemes of the A frames previous to the current frame, to ensure a smooth transition between the IPD parameter encoding scheme of the current frame and the IPD parameter encoding schemes of the A frames

previous to the current frame, to avoid a sudden change of an encoding effect.

[0070] With reference to any one of the second aspect or the first implementation to the eleventh implementation of the second aspect, in a twelfth implementation of the second aspect, the obtaining unit is specifically configured to obtain, by using the following calculation formula, the parameter indicating the correlation between the left channel and right channel of the current frame:

$$corr = \sum_{b=0}^N \frac{[E_l(b) + E_r(b) + 2x D_r(b)]}{[E_l(b) + E_r(b) + 2\sqrt{D_r^2(b) + D_i^2(b)}]}, \text{ where}$$

$$E_l(b) = \sum_{k=0}^L |L(k)|^2;$$

$$E_r(b) = \sum_{k=0}^L |R(k)|^2;$$

$$D_r(b) = \sum_{k=0}^L [L_r(k) \times R_r(k) + L_i(k) \times R_i(k)];$$

$$D_i(b) = \sum_{k=0}^L [L_i(k) \times R_r(k) - L_r(k) \times R_i(k)];$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L; \text{ and}$$

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L.$$

[0071] $E_l(b)$ indicates an energy sum of an audio-left channel, $E_r(b)$ indicates

an energy sum of an audio-right channel, $L_r(k)$ indicates a real part of a k^{th} frequency value of an audio-left channel frequency domain signal, $R_r(k)$ indicates a real part of

a k^{th} frequency value of an audio-right channel frequency domain signal, $L_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-left channel

frequency domain signal, $R_i(k)$ indicates an imaginary part of the k^{th} frequency value

of the audio-right channel frequency domain signal, L indicates a quantity of subband spectral coefficients, and N indicates a quantity of subbands, n indicates an index value

of a time domain signal, k indicates an index value of a frequency domain signal, $Length$ indicates a frame length, $x_L(n)$ indicates an audio-left channel time domain signal, $x_R(n)$ indicates an audio-right channel time domain signal, $L(k)$ indicates a k^{th} frequency value that is of the audio-left channel frequency domain signal and that is used to calculate the IPD parameter, and $R(k)$ indicates a k^{th} frequency value that is of the audio-right channel frequency domain signal and that is used to calculate the IPD parameter, where $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.

[0072] With reference to any one of the first implementation to the eleventh implementation of the first aspect, in a thirteenth implementation of the first aspect, the parameter indicating the correlation between the left channel and right channel of the current frame is obtained by using the following calculation formula:

$$corr = \sum_{i=0}^L \frac{|L(k) + R(k)|^2}{(|L(k)| + |R(k)|)^2}, \text{ where}$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi x n k}{L}}, 0 \leq k < L$$

; and

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi x n k}{L}}, 0 \leq k < L$$

[0073] L indicates a quantity of subband spectral coefficients, n indicates an index value of a time domain signal, k indicates an index value of a frequency domain signal, $Length$ indicates a frame length, $x_L(n)$ indicates an audio-left channel time domain signal, and $x_R(n)$ indicates an audio-right channel time domain signal, where $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.

[0074] With reference to any one of the first implementation to the eleventh implementation of the first aspect, in a fourteenth implementation of the first aspect, the parameter indicating the correlation between the left channel and right channel of the current frame is obtained by using the following calculation formula:

$$corr = \frac{\left(\sum_{k=1}^{L/2-1} |L(k)R^*(k)| \right)^2}{\sum_{k=1}^{L/2-1} (|L(k)|)^2 \sum_{k=1}^{L/2-1} (|R(k)|)^2}, \text{ where}$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L$$

; and

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L$$

.

[0075] L indicates a quantity of subband spectral coefficients, n indicates an index

5 value of a time domain signal, k indicates an index value of a frequency domain signal,

Length indicates a frame length, $x_L(n)$ indicates an audio-left channel time

domain signal, and $x_R(n)$ indicates an audio-right channel time domain signal,

where $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers. $R^*(k)$ indicates a

conjugate of $R(k)$. To be specific, $R^*(k)$ indicates a conjugate of a k^{th} frequency

10 value of an audio-right channel frequency domain signal.

[0076] According to a third aspect of the present invention, a terminal is provided and includes a memory and a processor.

[0077] The memory is configured to store a group of executable code.

[0078] The processor is configured to execute the executable code stored in the

15 memory to perform any one of the first aspect or the first implementation to the thirteenth implementation of the first aspect.

[0079] A fourth aspect of the present invention provides a storage medium. The storage medium stores executable code. When the executable code is executed, any one

of the first aspect or the first implementation to the thirteenth implementation of the

20 first aspect may be performed.

[0080] According to a fifth aspect of the present invention, a computer program is provided. The computer program may perform any one of the first aspect or the first implementation to the thirteenth implementation of the first aspect.

[0081] When the IPD parameter is encoded in the embodiments of the present invention, the reference parameter is obtained, the IPD parameter encoding scheme of the current frame corresponding to the current frame is determined based on the reference parameter, and the IPD parameter of the current frame is processed by using
5 the determined IPD parameter encoding scheme, so that not only the IPD parameter of the current frame can be adaptively processed, but also processing of the IPD parameter of the current frame matches with the current frame, to improve encoding quality of the multi-channel signal.

BRIEF DESCRIPTION OF DRAWINGS

10 **[0082]** To describe the technical solutions in the embodiments of the present invention more clearly, the following briefly describes the accompanying drawings required for describing the embodiments. Apparently, the accompanying drawings in the following description show merely some embodiments of the present invention, and a person of ordinary skill in the art may derive other drawings from these accompanying
15 drawings without creative efforts.

[0083] FIG. 1 is a schematic principle diagram of PS encoding;

[0084] FIG. 2 is a schematic principle diagram of PS decoding;

[0085] FIG. 3 is a schematic diagram of an application scenario of a solution of the present invention according to an embodiment of the present invention;

20 **[0086]** FIG. 4 is a schematic diagram of another application scenario of a solution of the present invention according to an embodiment of the present invention;

[0087] FIG. 5 is a schematic flowchart of an IPD parameter encoding method according to an embodiment of the present invention;

[0088] FIG. 6 is another schematic flowchart of an IPD parameter encoding method
25 according to an embodiment of the present invention;

[0089] FIG. 7 is another schematic flowchart of an IPD parameter encoding method according to an embodiment of the present invention;

[0090] FIG. 8 is a schematic structural diagram of an IPD parameter encoding

apparatus according to an embodiment of the present invention; and

[0091] FIG. 9 is a schematic structural diagram of an IPD parameter encoding apparatus according to another embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

5 **[0092]** The following clearly and completely describes technical solutions in the embodiments of the present invention with reference to the accompanying drawings in the embodiments of the present invention. Apparently, the described embodiments are merely some but not all of the embodiments of the present invention. All other embodiments obtained by a person of ordinary skill in the art based on the embodiments
10 of the present invention without creative efforts shall fall within the protection scope of the present invention.

[0093] FIG. 1 is a schematic principle diagram of PS encoding.

[0094] In PS encoding, an encoder downmixes (downmix) a stereo signal input from a multi-channel (for example, an x1 channel and an x2 channel) into a mono audio
15 signal, extracts spatial perception parameters of the stereo signal through spatial perception parameter analysis, obtains a mono audio bitstream through mono audio signal encoding, and obtains a spatial perception parameter bitstream through spatial perception parameter encoding. Further, the encoder performs bitstream multiplexing on the mono audio bitstream and the spatial perception parameter bitstream to obtain a
20 bitstream for stereo signal encoding.

[0095] FIG. 2 is a schematic principle diagram of PS decoding.

[0096] A decoder performs bitstream demultiplexing on a bitstream for stereo signal encoding to obtain a mono audio bitstream and a spatial perception parameter bitstream, performs mono audio signal decoding on the mono audio bitstream, and
25 performs spatial perception parameter decoding on the spatial perception parameter bitstream. Further, after decoding a mono audio signal, the decoder synthesizes a reconstructed stereo signal by using the spatial perception parameters.

[0097] In specific implementation, the spatial perception parameters in the

foregoing PS encoding and PS decoding include parameters such as IC, an ILD, an ITD, and an IPD. The IC describes an inter-channel correlation or correlation. This parameter determines perception of a sound field range, and can improve a sense of space and sound stability of an audio signal. An ILD parameter is used to distinguish between horizontal direction angles of stereo sources and describes an inter-channel intensity difference. This parameter affects frequency components of an entire spectrum. An ITD parameter and an IPD parameter are spatial perception parameters that indicate horizontal orientation of an acoustic source. The ILD parameter, the ITD parameter, and the IPD parameter determine human ears' perception of a location of a sound source, and can effectively determine a sound field location and is important for stereo signal restoration. Therefore, determining of parameters such as the IPD parameter is important for stereo signal restoration.

[0098] An application scenario of a solution of the present invention is shown in FIG. 3. After encoding (including encoding an IPD parameter) a collected multi-channel signal, a terminal 301 sends a code stream obtained through encoding to a radio access network (RAN: Radio Access Network) 302, for example, may directly send the code stream to a based station 3021 in the RAN 302. After passing through the based station 3021, the code stream is transmitted to a packet data network gateway (Packet Data Network Gateway, PGW) 3022. After passing through the PGW 3022, the code stream is transmitted to a core network 303, and specifically, the code stream may pass through a session border controller (SBC: Session Border Controller) 3031 in the core network 303. The code stream passing through the core network 303 enters a RAN 304. The RAN 304 includes a PGW 3042 and a base station 3041. After the code stream passes through the PGW 3042 and arrives at the base station 3041, the base station 3041 sends the code stream to a terminal 305, and the terminal 305 decodes the code stream and plays a multi-channel signal obtained through decoding.

[0099] It should be noted that, in the foregoing description, the RAN merely includes an example of two network elements (the base station and the PGW). During actual implementation, the RAN further includes a plurality of other network elements. For ease of description, another network element is omitted in the embodiments of the

present invention. Similarly, the core network also merely includes an example of the SBC. For ease of description, another network element is omitted in the embodiments of the present invention. It may be understood that network elements in the foregoing network are merely examples, and names of the network elements may be different in different networks. For example, the PGW is referred to as an evolved packet data gateway (ePDG: Evolved Packet Data Gateway) in an LTE network. Similarly, a connection manner between the foregoing network elements may also change with evolution of a network. Therefore, in the embodiments of the present invention, an application scenario of the present invention is not limited to the foregoing examples.

[00100] The terminal 301 and the terminal 305 are terminals that have a cellular network access capability, and may be a wearable device, a virtual reality (VR: Virtual Reality) device, an augmented reality (AR: Augmented Reality) device, a mobile phone, a tablet computer (Pad), a notebook computer (NB: Notebook Computer), a personal computer (PC: Personal Computer), or the like.

[0100] Another application scenario of a solution of the present invention is shown in FIG. 4. After encoding (including encoding an IPD parameter) a collected multi-channel signal, a terminal 401 sends the code stream obtained through encoding to a terminal 403 over an Internet 402. The terminal 403 decodes the code stream and plays a multi-channel signal obtained through decoding.

[0101] The terminal 401 and the terminal 403 are terminals having an Internet access capability, and may be wearable devices, VR devices, AR devices, mobile phones, Pads, NBs, PCs, or the like.

[0102] FIG. 5 is a schematic flowchart of an IPD parameter encoding method according to an embodiment of the present invention. The method includes the following steps.

[0103] S501. Obtain a reference parameter used to determine an IPD parameter encoding scheme of a current frame of a multi-channel signal.

[0104] During specific implementation, the IPD parameter encoding method provided in this embodiment of the present invention may be performed by an encoder that can encode the multi-channel signal. After encoding an IPD parameter of the

current frame by using the IPD parameter encoding method provided in this embodiment of the present invention, the encoder transmits the encoded IPD parameter. A decoder uses, for stereo synthesis processing, the IPD parameter obtained through decoding. The following describes in detail the IPD parameter encoding method provided in this embodiment of the present invention. It should be noted that the encoder and the decoder in this embodiment of the present invention are merely described in terms of a function, and actual forms of the encoder and the decoder may be the foregoing terminals. It may be understood that, in a call process, the terminal may have a function of both an encoder and a decoder. For ease of description, the current frame is directly used when the current frame of the multi-channel signal is subsequently described. The multi-channel signal in this embodiment of the present invention may specifically be a dual-channel signal, a three-channel signal, a four-channel signal, or the like. A specific quantity of channels corresponding to the multi-channel signal is not limited in this embodiment of the present invention.

[0105] In some feasible implementations, when encoding the IPD parameter of the current frame, the encoder may first obtain the reference parameter used to determine the IPD parameter encoding scheme of the current frame, and then determine the IPD parameter encoding scheme of the current frame based on the reference parameter. In other words, the reference parameter is used to determine the IPD parameter encoding scheme of the current frame. It may be understood that the reference parameter may alternatively be used to determine an encoding scheme for another parameter of the current frame. In this embodiment of the present invention, the reference parameter is not limited to being used to determine the IPD parameter encoding scheme. During specific implementation, the reference parameter may include at least one of a signal characteristic parameter of the current frame and signal characteristic parameters of A frames previous to the current frame. To be specific, the reference parameter may include the signal characteristic parameter of the current frame, the signal characteristic parameters of the A frames previous to the current frame, the signal characteristic parameter of the current frame and the signal characteristic parameters of the A frames previous to the current frame, or the like, and may specifically be determined based on

an actual application scenario. This is not limited herein. Herein, A is an integer not less than 1. To be specific, the A frames previous to the current frame may be one frame, two frames, three frames, or the like previous to the current frame. This is not limited herein. The frame previous to the current frame and the current frame are consecutive in a time sequence. The two frames previous to the current frame are consecutive in a time sequence and include the frame previous to the current frame. The three frames previous to the current frame are consecutive in a time sequence and include the two frames previous to the current frame.

[0106] During specific implementation, the signal characteristic parameter of the current frame may include one or more of parameters such as a parameter indicating correlation between left channel and right channel of the current frame, a variance of subband IPD parameters of the current frame, a signal type of the current frame, and an ITD parameter of the current frame. The parameter indicating the correlation between the left channel and right channel of the current frame, and the variance of the subband IPD parameters of the current frame may be obtained through calculation based on left channel frequency domain signal and right channel frequency domain signal of the multi-channel signals. The ITD parameter of the current frame may be determined based on a manner of extracting an ITD parameter of the multi-channel signal of the current frame. The manner of extracting the ITD parameter of the current frame may include an extraction manner provided in a standard protocol or an extraction manner known to a person skilled in the art. This is not limited herein.

[0107] The signal characteristic parameters of the A frames previous to the current frame include one or more of parameters such as a parameter indicating correlation between left channel and right channel of each of the A frames previous to the current frame, a variance of subband IPD parameters of each of the A frames previous to the current frame, an ITD parameter of each of the A frames previous to the current frame, an IPD parameter encoding scheme of each of the A frames previous to the current frame, and a signal type of each of the A frames previous to the current frame. Selection of a specific parameter or specific parameters may be determined based on an actual application scenario. This is not limited herein. The IPD parameter encoding scheme of

each of the A frames previous to the current frame may be stored in a cache or a memory. The signal type may include a voice type or a music type. The signal characteristic parameters of the A frames previous to the current frame may be stored in a cache. It may be understood that, after the signal characteristic parameter of the current frame is obtained, the signal characteristic parameter of the current frame is also stored in the cache to determine an IPD parameter encoding scheme of a following frame.

[0108] In some feasible implementations, the encoder may perform time-frequency transformation on left channel and right channel time domain signals of the multi-channel signal of the current frame to obtain the left channel frequency domain signal and right channel frequency domain signal of the current frame. Specifically, the foregoing time-frequency transformation may be implemented by using an implementation such as fast fourier transformation (Fast Fourier Transformation, FFT) or modified discrete cosine transform (Modified Discrete Cosine Transform, MDCT). This is not limited herein. The time-frequency transformation performed on the left channel and right channel time domain signals of the multi-channel signal of the current frame may be performed in a form of a frame or in a form of a subframe. One frame may usually include four subframes, two subframes, or eight subframes. A specific quantity of subframes may be determined based on a specific situation.

[0109] For example, in an implementation, when the encoder transforms the left channel and right channel time domain signals of the multi-channel signal of the current frame into the left channel frequency domain signal and right channel frequency domain signal through the FFT, the following transformation formulas may specifically be used:

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi x n k}{L}}, 0 \leq k < M$$

25

and

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi x n k}{L}}, 0 \leq k < M$$

[0110] Herein, n indicates an index value of a time domain signal, k indicates an index value of a frequency domain signal, *Length* indicates a frame length, *M*

indicates a time-frequency transformation length for transforming a time domain signal into a frequency domain signal, $x_L(n)$ indicates an audio-left channel time domain signal, $x_R(n)$ indicates an audio-right channel time domain signal, $L(k)$ indicates a k^{th} frequency value that is of an audio-left channel frequency domain signal and that is used to calculate the IPD parameter, and $R(k)$ indicates a k^{th} frequency value that is of an audio-right channel frequency domain signal and that is used to calculate the IPD parameter, where, $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.

[0111] A fourier transformation coefficient $X(k)$ of a sequence of real numbers $x(n)$ (including $x_L(n)$ and $x_R(n)$) is a complex number, and a real part of the sequence of real numbers $x(n)$ has an even symmetry and an imaginary part has an odd symmetry. To be specific, $X(k)$ has a conjugate symmetry. Both $X(0)$ and $X(N/2)$ are real numbers and meet the following relationship formula:

$$X(k) = X^*(N - k), \text{ where } 1 \leq k \leq L/2 - 1.$$

[0112] When discrete fourier transformation is performed, by using this conjugate symmetry, the encoder does not need to calculate and store $X(k)$, $L/2 + 1 \leq k \leq L - 1$, and imaginary parts of $X(0)$ and $X(L/2)$, but only needs to calculate $X(0)$ to $X(L/2)$, to reduce occupation of a computing resource and a storage resource of the encoder.

[0113] After transforming the left channel and right channel time domain signals of the current frame into the left channel frequency domain signal and right channel frequency domain signal in a form of a frame or a subframe, the encoder may calculate, based on the left channel frequency domain signal and right channel frequency domain signal, the parameter indicating the correlation between the left channel and right channel of the current frame.

[0114] In an implementation, the parameter indicating the correlation between the left channel and right channel of the current frame may be obtained through calculation by using the following calculation formula:

$$corr = \sum_{b=0}^N \frac{[E_l(b) + E_r(b) + 2 \times D_r(b)]}{[E_l(b) + E_r(b) + 2\sqrt{D_r^2(b) + D_i^2(b)}]},$$

$$\text{where, } E_l(b) = \sum_{k=0}^L |L(k)|^2,$$

$$E_r(b) = \sum_{k=0}^L |R(k)|^2,$$

$$D_r(b) = \sum_{k=0}^L [L_r(k) \times R_r(k) + L_i(k) \times R_i(k)], \text{ and}$$

$$D_i(b) = \sum_{k=0}^L [L_i(k) \times R_r(k) - L_r(k) \times R_i(k)].$$

5

[0115] $E_l(b)$ indicates an energy sum of an audio-left channel, $E_r(b)$ indicates an energy sum of an audio-right channel, $L_r(k)$ indicates a real part of a k^{th} frequency value of an audio-left channel frequency domain signal, $R_r(k)$ indicates a real part of a k^{th} frequency value of an audio-right channel frequency domain signal, $L_i(k)$ indicates an imaginary part of a k^{th} frequency value of the audio-left channel frequency domain signal, $R_i(k)$ indicates an imaginary part of a k^{th} frequency value of the audio-right channel frequency domain signal, L indicates a quantity of subband spectral coefficients, and N indicates a quantity of subbands.

10

[0116] In another implementation, the parameter indicating the correlation between the left channel and right channel of the current frame may be obtained through calculation by using the following calculation formula:

15

$$corr = \sum_{i=0}^L \frac{|L(k) + R(k)|^2}{(|L(k)| + |R(k)|)^2}.$$

[0117] In another implementation, the parameter indicating the correlation between the left channel and right channel of the current frame may be obtained through calculation by using the following calculation formula:

20

$$corr = \frac{\left(\sum_{k=1}^{L/2-1} L(k)R^*(k) \right)^2}{\sum_{k=1}^{L/2-1} (L(k))^2 \sum_{k=1}^{L/2-1} (R(k))^2}.$$

[0118] Herein, $R^*(k)$ indicates a conjugate of $R(k)$. To be specific, $R^*(k)$ indicates a conjugate of the k^{th} frequency value of the audio-right channel frequency domain signal.

5 **[0119]** In some feasible implementations, after transforming the left channel and right channel time domain signals of the current frame into the left channel frequency domain signal and right channel frequency domain signal, the encoder may further calculate the variance of the subband IPD parameters of the current frame based on the left channel frequency domain signal and right channel frequency domain signal.

10 Specifically, the encoder may first divide the left channel frequency domain signal and right channel frequency domain signal of the current frame into at least two subbands (in other words, a plurality of subbands). It is assumed that the left channel frequency domain signal and right channel frequency domain signal are divided into N_{subband} subbands, N_{subband} where is an integer greater than 2. Then, the encoder may calculate
15 IPD parameters of all subbands based on frequency domain signals of the N_{subband} subbands obtained through division, and calculate the variance of the subband IPD parameters of the current frame based on the IPD parameters of the N_{subband} subbands obtained through calculation.

[0120] In an implementation, the encoder may specifically calculate the subband
20 IPD parameter by using the following calculation formula:

$$IPD(b) = \arg \left(\sum_{k=A_{b-1}}^{A_b-1} L(k)R^*(k) \right), \quad 0 \leq b < N_{\text{subband}}.$$

[0121] Herein, b indicates an index value of a subband, and a frequency included in a subband b is $A_{b-1} \leq k \leq A_b - 1$.

[0122] In an implementation, the encoder may calculate the variance of the subband

IPD parameters by using the following calculation formula:

$$\text{var} = \frac{1}{N_{\text{subband}}} \sum_{b=0}^{N_{\text{subband}}-1} (IPD(b) - \text{avr})^2, \text{ where}$$
$$\text{avr} = \frac{1}{N_{\text{subband}}} \sum_{b=0}^{N_{\text{subband}}-1} IPD(b).$$

[0123] In another implementation of the present invention, the subband IPD parameter may be obtained through calculation by using the following calculation formula:

$$IPD(b) = \text{atan2}\left(\frac{D_i(b)}{D_r(b)}\right).$$

[0124] Herein, atan2 indicates an arctan function.

[0125] It may be understood that, during actual application, the subband IPD parameter may alternatively be obtained through calculation in another manner. A specific calculation manner of the subband IPD parameter is not limited in this embodiment of the present invention.

[0126] S502. Determine the IPD parameter encoding scheme of the current frame based on the obtained reference parameter.

[0127] During specific implementation, the encoder may adaptively select, based on the obtained reference parameter, one of a plurality of preset IPD parameter encoding schemes as the IPD parameter encoding scheme of the current frame.

[0128] The plurality of preset IPD parameter encoding schemes may include a first encoding scheme and a second encoding scheme. The first encoding scheme includes a group IPD parameter encoding scheme, skipping encoding an IPD parameter, setting a value of the IPD parameter to 0, or the like. The second encoding scheme includes an IPD parameter encoding scheme of a subband set, a subband IPD parameter encoding scheme, or the like. The subband IPD parameter encoding scheme may be encoding IPD parameters of all or some of subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame.

[0129] It may be understood that, in some implementations, it may be

predetermined that the first encoding scheme is specifically one of the following: the group IPD parameter encoding scheme, skipping encoding the IPD parameter, and setting the value of the IPD parameter to 0. Therefore, the encoder may directly determine that an encoding scheme is the group IPD parameter encoding scheme, skipping encoding the IPD parameter, or setting the value of the IPD parameter to 0, and does not need to perform selection from three encoding schemes. Correspondingly, it may further be predetermined that the second encoding scheme is specifically one of the IPD parameter encoding scheme of the subband set and the subband IPD parameter encoding scheme. Therefore, the encoder may directly determine that an encoding scheme is the IPD parameter encoding scheme of the subband set or the subband IPD parameter encoding scheme, and does not need to perform selection from two encoding schemes.

[0130] In some other implementations, the encoder may first determine the first encoding scheme or the second encoding scheme. When determining the first encoding scheme, the encoder selects one of the foregoing three encoding schemes. Correspondingly, when determining the second encoding scheme, the encoder selects one of the foregoing two second encoding schemes.

[0131] In some implementations, after the IPD parameter encoding scheme of the current frame is determined, the determined IPD parameter encoding scheme of the current frame may be encoded. A specific encoding scheme may be setting a preset parameter as a preset value, and indicating different encoding schemes by using different values. For example, in an implementation, the IPD parameter encoding scheme of the current frame may be indicated by using an encoding scheme flag bit. The flag bit may occupy one bit. When a value of this bit is 0, it indicates that the IPD parameter encoding scheme of the current frame is the first encoding scheme. When a value of this bit is 1, it indicates that the IPD parameter encoding scheme of the current frame is the second encoding scheme. Certainly, when a value of this bit is 1, it may alternatively indicate that the IPD parameter encoding scheme of the current frame is the first encoding scheme, and when a value of this bit is 0, it may alternatively indicate that the IPD parameter encoding scheme of the current frame is the second encoding

scheme. The decoder may determine the IPD parameter encoding scheme based on the value of the flag bit, to determine a corresponding decoding manner.

[0132] S503. Process an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame.

5 **[0133]** In some feasible implementations, the reference parameter includes the parameter indicating the correlation between the left channel and right channel of the current frame. In this case, when the IPD parameter encoding scheme of the current frame is to be determined, the parameter indicating the correlation between the left channel and right channel of the current frame may be compared with a predefined first
10 threshold. If a value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to the first threshold, the IPD parameter encoding scheme of the current frame is the first encoding scheme. On the contrary, if a value of the parameter indicating the correlation between the left channel and right channel of the current frame is less than the first threshold, the IPD
15 parameter encoding scheme of the current frame is the second encoding scheme. A value of the predefined first threshold ranges from 0.6 to 0.95. For example, the value may specifically be 0.89, 0.8, 0.75, or the like.

[0134] In some feasible implementations, the reference parameter includes the variance of the subband IPD parameters of the current frame. In this case, when the
20 IPD parameter encoding scheme of the current frame is to be determined, the variance of the subband IPD parameters of the current frame may be compared with a predefined second threshold. If a value of the parameter indicating the correlation between the left channel and right channel of the current frame is less than the second threshold, it indicates that the IPD parameter encoding scheme of the current frame is
25 the first encoding scheme. On the contrary, if a value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to the second threshold, it indicates that the IPD parameter encoding scheme of the current frame is the second encoding scheme. A value of the predefined second threshold ranges from 0.05 to 0.5. For example, the value may specifically be
30 0.45, 0.25, 0.3, or the like.

[0135] In some feasible implementations, the reference parameter includes the signal type of the current frame. For example, in an implementation, when the signal type of the current frame is a voice type, it may be determined that the IPD parameter encoding scheme of the current frame is the second encoding scheme. When the signal type of the current frame is a music type, it may be determined that the IPD parameter encoding scheme of the current frame is a first IPD parameter encoding scheme. It may be understood that, in some other embodiments, the signal type of the current frame is not the only reference parameter for determining the IPD parameter encoding scheme of the current frame. The IPD parameter encoding scheme may further be determined with reference to another reference parameter.

[0136] In some feasible implementations, the reference parameter includes an inter-channel time difference ITD parameter of the current frame. If a value of the ITD parameter of the current frame is greater than a preset threshold, it is determined that the IPD parameter encoding scheme of the current frame is the first encoding scheme. Otherwise, the IPD parameter encoding scheme of the current frame is the second encoding scheme. In an embodiment, the preset threshold may be 1, 2, 3, 4, or 5.

[0137] It may be understood that the signal characteristic parameter of the current frame may include only one of the foregoing parameters. In this case, the IPD parameter encoding scheme of the current frame may be determined provided that the parameter meets a corresponding parameter condition. Certainly, the signal characteristic parameter of the current frame may alternatively include at least two of the foregoing parameters. In this case, the IPD parameter encoding scheme of the current frame may be determined only when the at least two parameters respectively meet corresponding parameter conditions.

[0138] In some feasible implementations, the reference parameter includes the IPD parameter encoding scheme of each of the A frames previous to the current frame and the signal type of each of the A frames previous to the current frame. In this case, it may be determined whether the IPD parameter encoding scheme of each of the A frames previous to the current frame is a preset IPD parameter encoding scheme and whether the signal type of each of the A frames previous to the current frame is a preset signal

type. If the IPD parameter encoding scheme of each of the A frames previous to the current frame is the first encoding scheme, and the signal type of each of the A frames of the current frame is a music type, the IPD parameter encoding scheme of the current frame may be determined as the first encoding scheme.

- 5 **[0139]** For example, when $A = 1$, the A frames previous to the current frame are one frame previous to the current frame. If the IPD parameter encoding scheme of the frame previous to the current frame is the first encoding scheme, and the signal type of the frame previous to the current frame is a music type, the IPD parameter encoding scheme of the current frame may be determined as the first encoding scheme. Otherwise,
10 it is determined that the IPD parameter encoding scheme of the current frame is not the first encoding scheme, for example, the second encoding scheme.

- [0140]** When $A = 2$, the A frames previous to the current frame are two frames previous to the current frame. If IPD parameter encoding schemes of the two frames previous to the current frame both are first encoding schemes, and signal types of the
15 two frames previous to the current frame are music types, the IPD parameter encoding scheme of the current frame may be determined as the first encoding scheme. Otherwise, it is determined that the IPD parameter encoding scheme of the current frame is not the first encoding scheme, for example, the second encoding scheme.

- [0141]** In some feasible implementations, the reference parameter includes the ITD
20 parameter of the current frame, the variance of the subband IPD parameters of the current frame, and the signal type of each of the A frames previous to the current frame. In this case, an absolute value of the ITD parameter of the current frame may be compared with a predefined third threshold, the variance of the subband IPD parameters of the current frame is compared with a predefined fourth threshold, and it
25 is determined whether the signal type of each of the A frames previous to the current frame is a voice type. A value of the predefined third threshold may range from 0 to 4. For example, the value of the third threshold may be 4, 2, 0, or the like. A value of the predefined fourth threshold may range from 0.05 to 0.4. The value of the fourth threshold may be 0.4, 0.35, 0.25, 0.05, or the like. If the absolute value of the ITD
30 parameter of the current frame is greater than the third threshold, the variance of the

subband IPD parameters of the current frame is less than the fourth threshold, and the signal type of each of the A frames previous to the current frame is a voice type, the IPD parameter encoding scheme of the current frame may be determined as the first encoding scheme. Otherwise, it is determined that the IPD parameter encoding scheme of the current frame is not the first encoding scheme, for example, the second encoding scheme.

[0142] If the A frames previous to the current frames are the frame previous to the current frame, when the absolute value of the ITD parameter of the current frame is greater than the third threshold, the variance of the subband IPD parameters of the current frame is less than the fourth threshold, and the signal type of the frame previous to the current frame is a voice type, the IPD parameter encoding scheme of the current frame may be determined as the first encoding scheme. If the A frames previous to the current frames are the two frames previous to the current frame, when the absolute value of the ITD parameter of the current frame is greater than the third threshold, the variance of the subband IPD parameters of the current frame is less than the fourth threshold, and a signal type of each of the two frames previous to the current frame is a voice type, the IPD parameter encoding scheme of the current frame may be determined as the first encoding scheme.

[0143] In some feasible implementations, after determining that the IPD parameter encoding scheme of the current frame is the first encoding scheme, the encoder may process the IPD parameter of the current frame based on the first encoding scheme. For example, if the first encoding scheme is skipping encoding the IPD parameter, no operation is performed, to be specific, ending a process corresponding to encoding of the IPD parameter of the current frame. If the first encoding scheme is the group IPD parameter encoding scheme, the group IPD parameter of the current frame may be encoded. The group IPD parameter of the current frame is used as the IPD parameter of the current frame. If the first encoding scheme is setting the value of the IPD parameter to 0, the value of the IPD parameter of the current frame may be set to 0, and then the IPD parameter with a value of 0 is subsequently processed. For example, if the value of the IPD parameter is required as an input during some processing, after the

value of the IPD parameter of the current frame is set to 0, 0 may be used as the input of the processing.

[0144] In some implementations, the reference parameter includes the parameter indicating the correlation between the left channel and right channel of the current frame, and may further include the IPD parameter encoding scheme of the frame previous to the current frame and the signal type of the previous frame. If the value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to the first threshold, it may be determined that the IPD parameter encoding scheme of the current frame is the first encoding scheme. If the value of the parameter indicating the correlation between the left channel and right channel of the current frame is less than the first threshold, and the IPD parameter encoding scheme of the frame previous to the current frame is the first encoding scheme and the signal type of the previous frame is a music signal type, it may also be determined that the IPD parameter encoding scheme of the current frame is the first encoding scheme. Otherwise, if the value of the parameter indicating the correlation between the left channel and right channel of the current frame is less than the first threshold, and the IPD parameter encoding scheme of the frame previous to the current frame is the second encoding scheme or the signal type of the frame previous to the current frame is a voice type, it is determined that the IPD parameter encoding scheme of the current frame is the second encoding scheme.

[0145] Further, in an optional implementation, after the IPD parameter encoding scheme of the current frame is determined by using the foregoing implementation, whether to adjust the IPD parameter encoding scheme of the current frame may further be determined based on the IPD parameter encoding schemes of the A frames previous to the current frame. For example, whether to adjust the IPD parameter encoding scheme of the current frame may be determined based on the IPD parameter encoding scheme of the frame, two frames, three frames, four frames, or five frames previous to the current frame. In a possible implementation, if the IPD parameter encoding scheme of the current frame is the same as the IPD parameter encoding scheme of the current frame, the IPD parameter encoding scheme of the current frame does not need to be

adjusted. If the IPD parameter encoding scheme of the current frame is different from the IPD parameter encoding scheme of the current frame, adjusting the IPD parameter encoding scheme of the current frame may be considered. For example, the two frames, three frames, four frames, or five frames previous to the current frame, including the frame previous to the current frame use a same IPD parameter encoding scheme. In addition, when the IPD parameter encoding scheme used by the two frames, three frames, four frames, or five frames previous to the current frame is different from the IPD parameter encoding scheme of the current frame, the IPD parameter encoding scheme of the current frame may be adjusted. To be specific, the IPD parameter encoding scheme of the current frame is adjusted to be the same as the IPD parameter encoding scheme of the current frame. Adjusting the IPD parameter encoding scheme of the current frame may ensure that an encoding scheme of the current frame is kept consistent with that of a previous frame to some extent, so that an encoded code stream can ensure a smooth transition between the previous frame and the current frame during decoding, and auditory perception is better.

[0146] Specifically, in some implementations, the encoder may extract IPD parameters of at least some subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame when the encoding scheme is the second encoding scheme. The at least some subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame may specifically include all or some of the Nsubband subbands obtained through division of the left channel frequency domain signal and right channel frequency domain signal of the current frame. This is not limited herein. During specific implementation, a user may determine, based on encoding requirements such as an encoding rate or encoding quality of multi-channel signal encoding, that a frequency domain range of the left channel frequency domain signal and right channel frequency domain signal that are of the current frame and that are used to encode the group IPD parameter of the current frame includes an entire frequency domain range of the left channel frequency domain signal and right channel frequency domain signal of the current frame, to be specific, frequency domain signals of all subbands in the left

channel frequency domain signal and right channel frequency domain signal of the current frame, or includes a specific frequency domain range of the left channel frequency domain signal and right channel frequency domain signal of the current frame, to be specific, frequency domain signals of some frames in the left channel frequency domain signal and right channel frequency domain signal of the current frame. The frequency domain signals of some of the frames in the left channel frequency domain signal and right channel frequency domain signal of the current frame are included in the frequency domain signals of some of the subbands of the left channel frequency domain signal and right channel frequency domain signal.

[0147] In some feasible implementations, the encoder may not first extract IPD parameters of all or some of subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame, and then determine the IPD parameter encoding scheme of the current frame. If the first encoding scheme is skipping encoding the IPD parameter of the current frame, the IPD parameters of all or some of the subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame may not be directly extracted. In some other implementations, an IPD parameter of each of all or some of the subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame may alternatively first be extracted, and then the IPD parameter encoding scheme of the current frame is determined.

[0148] In some feasible implementations, if the encoder determines that the frequency domain range of the left channel frequency domain signal and right channel frequency domain signal that are of the current frame and that are used to encode the group IPD parameters of the left channel frequency domain signal and right channel frequency domain signal of the current frame is an entire frequency domain range of the left channel frequency domain signal and right channel frequency domain signal of the current frame, an IPD parameter of each of all subbands (to be specific, the Nsubband subbands of the current frame) of the left channel frequency domain signal and right channel frequency domain signal of the current frame may be extracted, an average value of IPD parameters of all extracted subbands may be calculated, and then

the obtained average value of the IPD parameters of all of the subbands is used as the group IPD parameter of the current frame. In an implementation, a formula for calculating the group IPD parameter of the current frame is as follows:

$$G_IPD = \frac{1}{N_{subband}} \sum_{b=0}^{N_{subband}-1} IPD(b).$$

5 **[0149]** G_IPD indicates the group IPD parameter of the current frame, and IPD(b) indicates an IPD parameter of a bth subband.

[0150] Optionally, in some feasible implementations, if the encoder determines that the frequency domain range of the left channel frequency domain signal and right channel frequency domain signal that are the current frame and that are used to encode
10 the group IPD parameters of the left channel frequency domain signal and right channel frequency domain signal of the current frame is a specific frequency domain range of the left channel frequency domain signal and right channel frequency domain signal of the current frame, for example, [k1, k2], to be specific, frequency domain signals between a (k1)th frequency and a (k2)th frequency, an IPD parameter of each of some
15 subbands (to be specific, subbands of the frequency domain signals between the (k1)th frequency and the (k2)th frequency) of the left channel frequency domain signal and right channel frequency domain signal of the current frame may be extracted, an average value of IPD parameters of all extracted subbands may be calculated, and then the obtained average value of the IPD parameters of all of the subbands is used as the
20 group IPD parameter of the current frame.

[0151] During specific implementation, the IPD parameters of the subbands of the frequency domain signals between the (k1)th frequency and the (k2)th frequency each may be predefined as an IPD parameter of each frequency. To be specific, in this case, calculation of the IPD parameters of the subbands may be replaced with calculation of
25 the IPD parameter of each frequency. The group IPD parameter of the current frame is calculated by using the IPD parameter of each frequency as an IPD parameter of each subband. A manner of calculating the IPD parameter of each frequency one by one in a preset frequency domain range [k1, k2] is as follows:

$$IPD(k) = \angle L(k)R^*(k), k_1 \leq k \leq k_2.$$

[0152] Herein, $\angle$ indicates calculating an angle of a complex number. $L(k)$ indicates a k^{th} frequency value of an audio-left channel frequency domain signal, and $R^*(k)$ indicates a conjugate of a k^{th} frequency value of an audio-right channel frequency domain signal.

[0153] Further, statistical processing may be performed on $IPD(k)$ in a preset range (a multi-frame signal of a multi-channel frequency domain signal, including a current frame and A frames previous to the current frame) to obtain the group IPD parameter.

[0154] For example, if the specific frequency domain range $[k_1, k_2]$ is a selection range of each of six frames of left channel frequency domain signal and right channel frequency domain signal, an average value of IPD parameters of $(k_2 - k_1 + 1)^{\text{th}}$ frequencies of each frame in left channel frequency domain signal and right channel frequency domain signal with the six frames may be calculated, and a calculation formula is as follows:

$$M_{IPD}^{[0]} = \frac{1}{k_2 - k_1 + 1} \sum_{k=k_1}^{k_2} IPD(k).$$

[0155] Further, an average value of IPD parameters of six consecutive frames including the current frame may be calculated, and is used as the group IPD parameter of the current frame:

$$M_{IPD} = \frac{1}{6} \sum_{i=-5}^0 M_{IPD}^{[i]}.$$

[0156] $M_{IPD}^{[0]}$ indicates an average value of IPD parameters of the current frame, $M_{IPD}^{[-1]}$ indicates an average value of IPD parameters of a frame previous to and adjacent to the current frame, $M_{IPD}^{[-2]}$ indicates an average value of IPD parameters of a frame previous to and adjacent to the frame previous to and adjacent to the current frame, and so on.

[0157] In some feasible implementations, the second encoding scheme may be an

IPD parameter encoding scheme of a subband set, or a subband IPD parameter encoding scheme. For example, when an IPD parameter encoding scheme of the current frame is a subband IPD parameter extraction manner, an IPD parameter of each of all or some of subbands of the left channel frequency domain signal and right channel frequency domain signal of the current frame are extracted, and then the IPD parameter of the subband is quantized in any quantization manner. This is not specifically limited.

[0158] FIG. 6 describes a procedure of an IPD parameter encoding method according to another embodiment of the present invention. This embodiment is described by using an example in which a reference parameter includes: a parameter indicating correlation between left channel and right channel of a current frame, an IPD parameter encoding scheme of a frame previous to the current frame, and a signal type of the frame previous to the current frame, a value of a first threshold is 0.75, and a value of A is 1. As shown in FIG. 6, this embodiment includes the following steps.

[0159] S601. Obtain the parameter indicating the correlation between the left channel and right channel of the current frame.

[0160] For a specific manner of obtaining the parameter indicating the correlation between the left channel and right channel of the current frame, refer to the foregoing description. Details are not described herein again.

[0161] S602. Determine whether a value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to 0.75. If the value of the parameter indicating the correlation between the left channel and right channel is less than 0.75, go to step S603; if the value of the parameter indicating the correlation between the left channel and right channel is greater than or equal to 0.75, go to step S607.

[0162] S603. Obtain the IPD parameter encoding scheme of the frame previous to the current frame.

[0163] The IPD parameter encoding scheme of the frame previous to the current frame may be stored in a cache. The IPD parameter encoding scheme of the previous frame may be skipping encoding an IPD parameter, or encoding subband IPD parameters of all or some of subbands of left channel frequency domain signal and right

channel frequency domain signal.

[0164] S604. Determine whether the IPD parameter encoding scheme of the frame previous to the current frame is skipping encoding the IPD parameter. If the IPD parameter encoding scheme of the frame previous to the current frame is skipping
5 encoding the IPD parameter, go to step S605. If the IPD parameter encoding scheme of the frame previous to the current frame is not skipping encoding the IPD parameter, go to step S608.

[0165] S605. Obtain the signal type of the frame previous to the current frame.

[0166] The signal type of the frame previous to the current frame may be stored in
10 the cache. The signal type of the previous frame may be a music signal type or a voice signal type.

[0167] S606. Determine whether the signal type of the frame previous to the current frame is the music signal type. If the signal type of the frame previous to the current frame is the music signal type, go to step S607; if the signal type of the frame previous
15 to the current frame is not the music signal type, go to step S608.

[0168] S607. Skip encoding the IPD parameter of the current frame, to be specific, determine that the IPD parameter encoding scheme of the current frame is skipping encoding the IPD parameter. End a processing procedure of the current frame.

[0169] S608. Encode the subband IPD parameters of all or some of the subbands of
20 the left channel frequency domain signal and right channel frequency domain signal of the current frame. A subband is in a one-to-one correspondence to a subband IPD parameter. In other words, each subband has a corresponding subband IPD parameter.

[0170] A specific process of obtaining the subband IPD parameter is described above, and details are not described herein again.

[0171] When the subband IPD parameters of some of the subbands of the left
25 channel frequency domain signal and right channel frequency domain signal of the current frame are encoded, to-be-encoded subband IPD parameters of a specific part of subbands may be set based on a requirement. For example, it is assumed that there are a subbands in total, and frequency values of the a subbands gradually increase from a
30 0th subband to an (a-1)th subband. In an embodiment, only subband IPD parameters

from the 0th subband to an (a-3)th subband may be encoded. In other words, subband IPD parameters of two subbands respectively with the highest frequency and the second highest frequency are not encoded. In another embodiment, only subband IPD parameters from a second subband to an (a-1)th subband may be encoded. In other words, subband IPD parameters of two subbands respectively with the lowest frequency and the second lowest frequency are not encoded. Certainly, subband IPD parameters of any two of the subbands may alternatively not be encoded. It may be understood that, in some embodiments, a quantity of subbands corresponding to encoded subband IPD parameters may be set based on a specific requirement. For example, subband IPD parameters of (a-1) subbands in the a subbands may be encoded, or subband IPD parameters of (a-2) subbands in the a subbands may be encoded, or subband IPD parameters of (a-3) subbands in the a subbands may be encoded, or subband IPD parameters of (a-4) subbands in the a subbands may be encoded.

[0172] It may be understood that a performing sequence of obtaining steps S601, S603, and S605 in FIG. 6 is not limited. Any one of the obtaining steps S601, S603, and S605 may be first performed, or the obtaining steps S601, S603, and S605 may be simultaneously performed. Similarly, a performing sequence of determining steps S602, S604, and S606 is not limited, either. Any one of the determining steps S602, S604, and S606 may be first performed, or the determining steps S602, S604, and S606 may be simultaneously performed.

[0173] FIG. 7 describes a procedure of an IPD parameter encoding method according to another embodiment of the present invention. This embodiment includes the following steps.

[0174] S701. Obtain a reference parameter used to determine an IPD parameter encoding scheme of a current frame of a multi-channel signal.

[0175] For a specific reference parameter and a specific parameter of obtaining the reference parameter, refer to description in the foregoing embodiment. Details are not described herein again.

[0176] S702. Determine the IPD parameter encoding scheme of the current frame

based on the obtained parameter.

[0177] For the IPD parameter encoding scheme of the current frame, refer to the description in the foregoing embodiment. Details are not described herein again.

[0178] S703. Determine whether the IPD parameter encoding scheme of the current
5 frame is the same as an IPD parameter encoding scheme of a frame previous to the current frame. If the IPD parameter encoding scheme of the current frame is the same as the IPD parameter encoding scheme of the frame previous to the current frame, go to step S704. If the IPD parameter encoding scheme of the current frame is different from the IPD parameter encoding scheme of the frame previous to the current frame,
10 go to step S705.

[0179] S704. Set a preset value of a counter to 0, and go to step S707.

[0180] In other words, the IPD parameter encoding scheme of the current frame does not need to be adjusted.

[0181] S705. Determine whether a preset value of the counter is less than 5. If the
15 preset value of the counter is less than 5, go to step S706. If the preset value of the counter is greater than or equal to 5, go to step S707.

[0182] S706. Adjust the IPD parameter encoding scheme of the current frame, and increase the preset value of the counter by 1, and go to step S708.

[0183] When the IPD parameter encoding scheme of the current frame is a first
20 encoding scheme, the IPD parameter encoding scheme of the current frame is adjusted to a second encoding scheme. For example, when the IPD parameter encoding scheme of the current frame is skipping encoding an IPD parameter, the IPD parameter encoding scheme of the current frame is adjusted to encoding subband IPD parameters of all or some of subbands of left channel frequency domain signal and right channel
25 frequency domain signal of the current frame. Alternatively, when the IPD parameter encoding scheme of the current frame is a second encoding scheme, the IPD parameter encoding scheme of the current frame is adjusted to a first encoding scheme. For example, when the IPD parameter encoding scheme of the current frame is encoding subband IPD parameters of all or some of subbands of left channel frequency domain
30 signal and right channel frequency domain signal of the current frame, the IPD

parameter encoding scheme of the current frame is adjusted to skipping encoding an IPD parameter.

[0184] S707. Process an IPD parameter of the current frame by using the determined IPD parameter encoding scheme of the current frame. End a procedure.

5 **[0185]** S708. Process an IPD parameter of the current frame by using the adjusted IPD parameter encoding scheme of the current frame.

[0186] In another implementation of the present invention, when whether to adjust the IPD parameter encoding scheme of the current frame is to be determined, two counters may be used. A specific processing manner is as follows:

10 **[0187]** When the IPD parameter encoding scheme of the current frame and the IPD parameter encoding scheme of the frame previous to the current frame both are first encoding schemes, a value of a first counter is set to 0. If the IPD parameter encoding scheme of the frame previous to the current frame is the first encoding scheme, the IPD parameter encoding scheme of the current frame is the second encoding scheme, and
15 the value of the first counter is less than 5, the IPD parameter encoding scheme of the current frame is adjusted to the first encoding scheme, and the value of the first counter is increased by 1. The first encoding scheme may be skipping encoding the IPD parameter, and the second encoding scheme may be encoding the subband IPD parameters of all or some of the subbands of the left channel frequency domain signal
20 and right channel frequency domain signal.

[0188] When the IPD parameter encoding scheme of the current frame and the IPD parameter encoding scheme of the frame previous to the current frame both are second encoding schemes, a value of a second counter is set to 0. If the IPD parameter encoding scheme of the frame previous to the current frame is the second encoding scheme, the
25 IPD parameter encoding scheme of the current frame is the first encoding scheme, and the value of the second counter is less than 5, the IPD parameter encoding scheme of the current frame is adjusted to the second encoding scheme, and the value of the second counter is increased by 1. The first encoding scheme may be skipping encoding the IPD parameter, and the second encoding scheme may be encoding the subband IPD
30 parameters of all or some of the subbands of the left channel frequency domain signal

and right channel frequency domain signal.

[0189] It may be understood that, if the IPD parameter encoding scheme of the current frame is adjusted, the adjusted IPD parameter encoding scheme of the current frame is cached. In other words, when an IPD parameter encoding scheme of a frame
5 after the current frame is to be determined, refer to the adjusted IPD parameter encoding scheme of the current frame.

[0190] FIG. 8 is a schematic structural diagram of an embodiment of an IPD parameter encoding apparatus 800 according to an embodiment of the present invention. The IPD parameter encoding apparatus 800 includes:

10 an obtaining unit 801, configured to obtain a reference parameter, where the reference parameter is used to determine an inter-channel phase difference IPD parameter encoding scheme of a current frame of a multi-channel signal, and

for a specific reference parameter and a specific obtaining parameter of the reference parameter, reference may be made to description in the foregoing
15 embodiment, and details are not described herein again;

a determining unit 802, configured to determine an IPD parameter encoding scheme of the current frame based on the reference parameter obtained by the obtaining unit 801, where the determined IPD parameter encoding scheme of the current frame is one of at least two preset IPD parameter encoding schemes, and

20 for determining the IPD parameter encoding scheme of the current frame, reference may specifically be made to description in a method embodiment part, for specific encoding schemes of the at least two preset IPD parameter encoding schemes, reference may also be made to description in the method embodiment part, and details are not described herein again; and

25 a processing unit 803, configured to process an IPD parameter of the current frame based on the IPD parameter encoding scheme that is of the current frame and that is determined by the determining unit 802.

[0191] For a specific processing process, refer to description in the method embodiment part. Details are not described herein again.

30 **[0192]** In another embodiment of the present invention, the determining unit 802

may further be configured to determine whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted. In this case, as shown in FIG. 8, the IPD parameter encoding apparatus 800 may further include an adjusting unit 804, configured to adjust the determined IPD parameter encoding scheme of the current frame when the determining unit 802 determines that the determined IPD parameter encoding scheme of the current frame needs to be adjusted. Correspondingly, the processing unit 803 is specifically configured to process the IPD parameter of the current frame based on the adjusted IPD parameter encoding scheme of the current frame. For how to determine whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted, and how to adjust the IPD parameter encoding scheme of the current frame, refer to description in the method embodiment. Details are not described herein again.

[0193] As shown in FIG. 8, in another embodiment of the present invention, the IPD parameter encoding apparatus 800 may further include an encoding unit 805, configured to encode the IPD parameter encoding scheme that is of the current frame and that is determined by the determining unit 802. For example, an encoding scheme flag bit may be set, and the flag bit occupies one bit, to indicate whether the IPD parameter encoding scheme of the current frame is a first encoding scheme or a second encoding scheme. In this way, a decoder can determine the IPD parameter encoding scheme of the current frame based on the encoding scheme flag bit, to perform decoding by using a corresponding decoding manner. It may be understood that, in some implementations, the encoding unit 805 and the processing unit 803 may be one logical unit.

[0194] FIG. 9 describes a structure of a terminal according to another embodiment of the present invention. The terminal may be a wearable device, a VR device, an AR device, a mobile phone, a pad, a notebook, a PC, or the like. As shown in FIG. 9, the terminal provided in this embodiment of the present invention includes a network interface 910 (as shown in a dotted line box in FIG. 9). The network interface 910 is configured to send and receive data. For example, when the terminal serves as an encoder, sent data includes a multi-channel signal (carried in a code stream) encoded

by the terminal. When an IPD parameter is encoded, the sent data further includes the IPD parameter (the IPD parameter is also carried in the code stream and may be used as a part of the multi-channel signal). When the terminal serves as a decoder, received data includes a code stream carrying the multi-channel signal. When the encoder
5 encodes the IPD parameter, the received data may further include the IPD parameter. A specific form of the network interface 910 may be various, and may specifically be different based on a specific form of the terminal and different application scenarios. FIG. 9 shows three examples. A first example is a cellular network access module including a radio frequency transceiver (RF Transceiver) 901 and a modem (Modem)
10 902. The cellular network access module is configured to access a mobile communications network provided by a mobile operator, such as a 2G (2nd Generation), 3G (3rd Generation), 4G (4th Generation), to be specific, a long term evolution (LTE: Long Term Evolution) network, future 5G (5th Generation) or 6G (6th Generation) network, or the like. A second example is a wireless fidelity (WiFi: Wireless Fidelity)
15 module 903, configured to access a network by accessing an accessing point (AP: Access Point). A third example is an Ethernet network adapter 904, configured to access the network by using a twisted pair cable or an optical fiber. It should be noted that the terminal does not need to include all of the foregoing three network interfaces, and may include only at least one of the foregoing three network interface terminals, so that the
20 terminal can access the network. In addition, a network interface included in the terminal may not be one of the foregoing three types, for example, may be a Bluetooth interface or a modem. Therefore, a specific form of the network interface 910 is not limited in this embodiment of the present invention, and implementation of this embodiment of the present invention is not affected provided that the terminal can
25 access the network through the network interface 910.

[0195] As shown in FIG. 9, the terminal may further include a microphone 905, configured to collect a multi-channel signal. An analog-to-digital converter may be built in the microphone 905. Therefore, the microphone may convert a collected multi-channel signal in an analog signal form into a multi-channel signal in a digital signal
30 form. Certainly, no analog-to-digital converter may alternatively be built in the

microphone 905. In this case, the terminal further needs to include an analog-to-digital converter, to perform analog-to-digital conversion on a multi-channel signal in an analog signal form collected by the microphone 905 and obtain a multi-channel signal in a digital signal form. There may be one, two, three, or more microphones 905. A specific quantity of microphones 905 is not limited in this embodiment of the present invention. It may be understood that the terminal may alternatively collect the multi-channel signal by using an external microphone. In this case, the terminal needs to include an adaptation interface of the external microphone, to facilitate insertion of the external microphone and then implement data exchange between the terminal and the external microphone.

[0196] As shown in FIG. 9, the terminal may further include a loudspeaker 906, configured to play a multi-channel signal obtained through decoding by the terminal. If a bitstream that includes the multi-channel signal and that is received by the terminal includes an IPD parameter, this decoding process may be performed based on the IPD parameter. A digital-to-analog converter may be built in the loudspeaker 906. In other words, the terminal may send a multi-channel signal in a digital signal form to the loudspeaker 906, and

the loudspeaker 906 performs analog-to-digital conversion on the multi-channel signal in the digital signal form, to convert the multi-channel signal in the digital signal form into and play a multi-channel signal in an analog signal form. Certainly, no digital-to-analog converter may alternatively be built in the loudspeaker 906. In this case, the terminal needs to include an analog-to-digital converter to convert the multi-channel signal in the digital signal form into the multi-channel signal in the analog signal form, and sends the multi-channel signal in the analog signal form to the loudspeaker 906 for playing. There may be one, two, three, or more loudspeakers 906. A quantity of loudspeakers 906 is not limited in this embodiment of the present invention. It may be understood that the terminal may alternatively play the multi-channel signal by using an external loudspeaker. In this case, the terminal needs to include an adaptation interface of the external loudspeaker, to facilitate insertion of the external loudspeaker and then implement data exchange with the external loudspeaker.

[0197] As shown in FIG. 9, the terminal further includes a processor 908 and a memory 909. The memory 909 is configured to store code executable by the processor, and the processor 908 is configured to execute the code stored in the memory 909, to implement the method described in the foregoing method embodiments.

5 **[0198]** As shown in FIG. 9, the terminal further includes a bus 907. Data exchange between the foregoing components such as the network interface 910, the microphone 905, the loudspeaker 906, the processor 908, and the memory 909 may be performed by using the bus 907. It may be understood that FIG. 9 merely describes an example of the structure of the terminal. Some connection relationships in the structure are
10 simplified. During actual application, components such as the network interface 910, the microphone 905, or the loudspeaker 906 may not be directly connected to the bus 907. In other words, data exchange between the components such as the network interface 910, the microphone 905, or the loudspeaker 906 may further need to pass through another component.

15 **[0199]** In some implementations, the processor 908 and the memory 909 may further have a data exchange interface. Data exchange between the processor 908 and the memory 909 may be directly performed through the data exchange interface, and does not need to pass through the bus 907, to improve data exchange efficiency between the processor 908 and the memory 909.

20 **[0200]** In some implementations, the processor 908 and the memory 909 may be a processor and a memory in a digital signal processor (DSP: Digital Signal Processor). In other words, both the processor 908 and the memory 909 are encapsulated in the DSP. In this case, data exchange between the processor 908 and the memory 909 may be performed through a data exchange interface inside the DSP. In addition, because both
25 the processor 908 and the memory 909 are encapsulated in the DSP, the processor 908 and the memory 909 may exchange data with another component through one data exchange interface between the DSP and the bus 907.

[0201] An embodiment of the present invention further provides a computer program. When the computer program is executed, a procedure of any one of the
30 foregoing method embodiments may be executed.

[0202] An embodiment of the present invention further provides a storage medium. The storage medium stores executable code, and when the executable code is executed, a procedure in any one of the foregoing method embodiments may be executed.

[0203] A person of ordinary skill in the art may understand that all or some of
5 procedures of the method in the embodiments may be implemented by a computer program instructing related hardware. The program may be stored in a computer readable storage medium. When the program runs, the procedures of the method in the embodiments are included. The storage medium may include: a magnetic disk, an optical disc, a read-only memory (Read-Only Memory, ROM), a random access
10 memory (Random Access Memory, RAM), or the like.

[0204] In the specification, claims, and accompanying drawings of the present invention, the terms "first", "second", "third", "fourth", and the like are intended to distinguish between different objects but do not indicate a specific order. In addition, the terms "include", "have", and any other variant thereof are intended to cover a non-
15 exclusive inclusion. For example, a process, a method, a system, a product, or a device that includes a series of steps or units is not limited to the listed steps or units, but optionally further includes a step or unit that is not listed, or optionally further includes another inherent step or unit of the process, method, system, product, or device.

[0205] What is disclosed above is merely example embodiments of the present
20 invention, and certainly is not intended to limit the protection scope of the present invention. Therefore, equivalent variations made in accordance with the claims of the present invention shall fall within the scope of the present invention.

CLAIMS

What is claimed is:

1. An inter-channel phase difference parameter encoding method, comprising:
obtaining a reference parameter used to determine an inter-channel phase
5 difference IPD parameter encoding scheme of a current frame of a multi-channel signal;
determining the IPD parameter encoding scheme of the current frame based on the
reference parameter, wherein the determined IPD parameter encoding scheme of the
current frame is one of at least two preset IPD parameter encoding schemes; and
processing an IPD parameter of the current frame based on the determined IPD
10 parameter encoding scheme of the current frame.

2. The method according to claim 1, wherein the reference parameter comprises at
least one of a signal characteristic parameter of the current frame and signal
characteristic parameters of A frames previous to the current frame, wherein A is an
integer not less than 1;

15 the signal characteristic parameter of the current frame comprises at least one of a
parameter indicating correlation between left channel and right channel of the current
frame, a variance of subband IPD parameters of the current frame, a signal type of the
current frame, and the inter-channel time difference ITD parameter of the current frame;
and

20 the signal characteristic parameters of the A frames previous to the current frame
comprise at least one of a parameter indicating correlation between left channel and
right channel of each of the previous A frames, a variance of subband IPD parameters
of each of the previous A frames, an ITD parameter of each of the previous A frames,
an IPD parameter encoding scheme of each of the previous A frames, and a signal type
25 of each of the previous A frames, wherein

the signal type comprises a voice type or a music type.

3. The method according to claim 2, wherein the reference parameter comprises
the parameter indicating the correlation between the left channel and right channel of
the current frame; and

if a value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to a first threshold, the IPD parameter encoding scheme of the current frame is a first encoding scheme in the at least two IPD parameter encoding schemes.

5 4. The method according to claim 3, wherein the first threshold is 0.75.

5. The method according to any one of claims 2 to 4, wherein the reference parameter comprises the IPD parameter encoding scheme of each of the previous A frames and the signal type of each of the previous A frames; and

10 if the IPD parameter encoding scheme of each of the previous A frames is the first encoding scheme in the at least two IPD parameter encoding schemes, and the signal type of each of the previous A frames is a music type, the IPD parameter encoding scheme of the current frame is the first encoding scheme.

6. The method according to claim 5, wherein a value of A is 1.

15 7. The method according to any one of claims 3 to 6, wherein the first encoding scheme comprises any one of the following manners:

 a group inter-channel phase difference group IPD parameter encoding scheme;

 skipping encoding an IPD parameter; or

 setting a value of an IPD parameter to 0.

20 8. The method according to any one of claims 3 to 7, wherein if the IPD parameter encoding scheme of the current frame is not the first encoding scheme, the IPD parameter encoding scheme of the current frame is a second encoding scheme, wherein

 the second encoding scheme comprises an IPD parameter encoding scheme of a subband set, or a subband IPD parameter encoding scheme, and the subband IPD parameter encoding scheme is encoding subband IPD parameters of some or all of
25 subbands of the current frame.

9. The method according to claim 8, wherein the second encoding scheme is the subband IPD parameter encoding scheme; and

 the processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame comprises:

30 calculating IPD parameters of all or some of subbands of left channel frequency

domain signal and right channel frequency domain signal of the current frame; and

encoding the IPD parameters that are of all or some of the subbands and that are obtained through calculation.

10. The method according to any one of claims 1 to 9, wherein the method further
5 comprises:

performing encoding based on the determined IPD parameter encoding scheme of the current frame.

11. The method according to any one of claims 1 to 10, wherein before the
processing an IPD parameter of the current frame based on the determined IPD
10 parameter encoding scheme of the current frame, the method further comprises:

determining whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted;

adjusting the determined IPD parameter encoding scheme of the current frame
when it is determined that the determined IPD parameter encoding scheme of the
15 current frame needs to be adjusted; and

the processing an IPD parameter of the current frame based on the determined IPD
parameter encoding scheme of the current frame comprises:

processing the IPD parameter of the current frame based on the adjusted IPD
parameter encoding scheme of the current frame.

20 12. The method according to claim 11, wherein the determining whether the
determined IPD parameter encoding scheme of the current frame needs to be adjusted
is performed based on IPD parameter encoding schemes of the A frames previous to the
current frame.

13. The method according to any one of claims 2 to 12, wherein the parameter
25 indicating the correlation between the left channel and right channel of the current
frame is obtained by using the following calculation formula:

$$corr = \sum_{b=0}^N \frac{[E_l(b) + E_r(b) + 2xD_r(b)]}{[E_l(b) + E_r(b) + 2\sqrt{D_r^2(b) + D_i^2(b)}]}, \text{ wherein}$$

$$E_l(b) = \sum_{k=0}^L |L(k)|^2 ;$$

$$E_r(b) = \sum_{k=0}^L |R(k)|^2 ;$$

$$D_r(b) = \sum_{k=0}^L [L_r(k) \times R_r(k) + L_i(k) \times R_i(k)] ;$$

$$D_i(b) = \sum_{k=0}^L [L_i(k) \times R_r(k) - L_r(k) \times R_i(k)] ;$$

$$5 \quad L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L ; \text{ and}$$

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi n x k}{L}}, 0 \leq k < L , \text{ wherein}$$

$E_l(b)$ indicates an energy sum of an audio-left channel, $E_r(b)$ indicates an energy sum of an audio-right channel, $L_r(k)$ indicates a real part of a k^{th} frequency value of an audio-left channel frequency domain signal, $R_r(k)$ indicates a real part of a k^{th} frequency value of an audio-right channel frequency domain signal, $L_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-left channel frequency domain signal, $R_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-right channel frequency domain signal, L indicates a quantity of subband spectral coefficients, and N indicates a quantity of subbands, n indicates an index value of a time domain signal, k indicates an index value of a frequency domain signal, $Length$ indicates a frame length, $x_L(n)$ indicates an audio-left channel time domain signal, $x_R(n)$ indicates an audio-right channel time domain signal, $L(k)$ indicates a k^{th} frequency value that is of the audio-left channel frequency domain signal and that is used to calculate the IPD parameter, and $R(k)$ indicates a k^{th} frequency value that is of the audio-right channel frequency domain signal and that is used to

calculate the IPD parameter, wherein $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.

14. An inter-channel phase difference parameter encoding apparatus, comprising:

an obtaining unit, configured to obtain a reference parameter, wherein the
5 reference parameter is used to determine an inter-channel phase difference IPD
parameter encoding scheme of a current frame of a multi-channel signal;

a determining unit, configured to determine the IPD parameter encoding scheme
of the current frame based on the reference parameter, wherein the determined IPD
parameter encoding scheme of the current frame is one of at least two preset IPD
10 parameter encoding schemes; and

a processing unit, configured to process an IPD parameter of the current frame
based on the determined IPD parameter encoding scheme of the current frame.

15. The apparatus according to claim 14, wherein the reference parameter
comprises at least one of a signal characteristic parameter of the current frame and
15 signal characteristic parameters of A frames previous to the current frame, wherein A is
an integer not less than 1;

the signal characteristic parameter of the current frame comprises at least one of a
parameter indicating correlation between left channel and right channel of the current
frame, a variance of subband IPD parameters of the current frame, a signal type of the
20 current frame, and the inter-channel time difference ITD parameter of the current frame;
and

the signal characteristic parameters of the A frames previous to the current frame
comprise at least one of a parameter indicating correlation between left channel and
right channel of each of the previous A frames, a variance of subband IPD parameters
25 of each of the previous A frames, an ITD parameter of each of the previous A frames,
an IPD parameter encoding scheme of each of the previous A frames, and a signal type
of each of the previous A frames, wherein

the signal type comprises a voice type or a music type.

16. The apparatus according to claim 15, wherein the reference parameter

comprises the parameter indicating the correlation between the left channel and right channel of the current frame; and

if a value of the parameter indicating the correlation between the left channel and right channel of the current frame is greater than or equal to a first threshold, the IPD parameter encoding scheme of the current frame is a first encoding scheme in the at least two IPD parameter encoding schemes.

17. The apparatus according to claim 16, wherein the first threshold is 0.75.

18. The apparatus according to any one of claims 15 to 17, wherein the reference parameter comprises the IPD parameter encoding scheme of each of the previous A frames and the signal type of each of the previous A frames; and

if the IPD parameter encoding scheme of each of the previous A frames is the first encoding scheme in the at least two IPD parameter encoding schemes, and the signal type of each of the previous A frames is a music type, the IPD parameter encoding scheme of the current frame is the first encoding scheme.

19. The apparatus according to claim 18, wherein a value of A is 1.

20. The apparatus according to any one of claims 16 to 19, wherein the first encoding scheme comprises any one of the following manners:

a group inter-channel phase difference group IPD parameter encoding scheme;

skipping encoding an IPD parameter; or

setting a value of an IPD parameter to 0.

21. The apparatus according to any one of claims 16 to 20, wherein if the IPD parameter encoding scheme of the current frame is not the first encoding scheme,

the IPD parameter encoding scheme of the current frame is a second encoding scheme, wherein

the second encoding scheme comprises an IPD parameter encoding scheme of a subband set, or a subband IPD parameter encoding scheme, and the subband IPD parameter encoding scheme is encoding subband IPD parameters of some or all of subbands of the current frame.

22. The apparatus according to claim 21, wherein the second encoding scheme is the subband IPD parameter encoding scheme; and

the processing an IPD parameter of the current frame based on the determined IPD parameter encoding scheme of the current frame comprises:

calculating IPD parameters of all or some of subbands of left channel frequency domain signal and right channel frequency domain signal of the current frame; and

5 encoding the IPD parameters that are of all or some of the subbands and that are obtained through calculation.

23. The apparatus according to any one of claims 14 to 22, wherein the method further comprises:

10 performing encoding based on the determined IPD parameter encoding scheme of the current frame.

24. The apparatus according to any one of claims 14 to 23, wherein the determining unit is further configured to determine whether the IPD parameter encoding scheme that is of the current frame and that is determined by the determining unit needs to be adjusted; and

15 the apparatus further comprises:

an adjusting unit, configured to adjust the determined IPD parameter encoding scheme of the current frame when the determining unit determines that the determined IPD parameter encoding scheme of the current frame needs to be adjusted; and

20 the processing unit, further configured to process the IPD parameter of the current frame based on the adjusted IPD parameter encoding scheme of the current frame.

25. The apparatus according to claim 24, wherein the determining whether the determined IPD parameter encoding scheme of the current frame needs to be adjusted is performed based on IPD parameter encoding schemes of the A frames previous to the current frame.

26. The apparatus according to any one of claims 14 to 25, wherein the obtaining unit is specifically configured to obtain, by using the following calculation formula, the parameter indicating the correlation between the left channel and right channel of the current frame:

$$corr = \sum_{b=0}^N \frac{[E_l(b) + E_r(b) + 2 \times D_r(b)]}{[E_l(b) + E_r(b) + 2\sqrt{D_r^2(b) + D_i^2(b)}]}, \text{ wherein}$$

$$E_l(b) = \sum_{k=0}^L |L(k)|^2 ;$$

$$E_r(b) = \sum_{k=0}^L |R(k)|^2 ;$$

$$D_r(b) = \sum_{k=0}^L [L_r(k) \times R_r(k) + L_i(k) \times R_i(k)] ;$$

$$5 \quad D_i(b) = \sum_{k=0}^L [L_i(k) \times R_r(k) - L_r(k) \times R_i(k)] ;$$

$$L(k) = \sum_{n=0}^{Length-1} x_L(n) x e^{-j \frac{2\pi \times n \times k}{L}}, 0 \leq k < L ; \text{ and}$$

$$R(k) = \sum_{n=0}^{Length-1} x_R(n) x e^{-j \frac{2\pi \times n \times k}{L}}, 0 \leq k < L , \text{ wherein}$$

$E_l(b)$ indicates an energy sum of an audio-left channel, $E_r(b)$ indicates an energy sum of an audio-right channel, $L_r(k)$ indicates a real part of a k^{th} frequency

10 value of an audio-left channel frequency domain signal, $R_r(k)$ indicates a real part of a k^{th} frequency value of an audio-right channel frequency domain signal, $L_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-left channel

frequency domain signal, $R_i(k)$ indicates an imaginary part of the k^{th} frequency value of the audio-right channel frequency domain signal, L indicates a quantity of subband spectral coefficients, and N indicates a quantity of subbands, n indicates an index value

15 of a time domain signal, k indicates an index value of a frequency domain signal, $Length$ indicates a frame length, $x_L(n)$ indicates an audio-left channel time domain signal, $x_R(n)$ indicates an audio-right channel time domain signal, $L(k)$ indicates a k^{th} frequency value that is of the audio-left channel frequency domain signal

20 and that is used to calculate the IPD parameter, and $R(k)$ indicates a k^{th} frequency

value that is of the audio-right channel frequency domain signal and that is used to calculate the IPD parameter, wherein $x_L(n)$ and $x_R(n)$ indicate sequences of real numbers.