Claims

[Claim 1] A bit allocating method comprising:
determining the allocated number of bits in decimal point units based on each frequency band so that a Signal-to-Noise Ratio (SNR) of a spectrum existing in a predetermined frequency band is maximized within a range of the allowable number of bits for a given frame; and
adjusting the allocated number of bits based on each frequency band.

[Claim 2] The bit allocating method of claim 1, wherein the determining of the allocated number of bits is performed by using spectral energy of the predetermined frequency band and the allowable number of bits for the given frame.

[Claim 3] The bit allocating method of claim 1, wherein the determining of the allocated number of bits comprises determining the allocated number of bits so that a difference between a sum of the numbers of bits allocated to all frequency bands included in the given frame and the allowable number of bits for the given frame is minimized.

[Claim 4] The bit allocating method of claim 1, wherein the determining of the allocated number of bits is performed by using the equation below

$$L_b = \frac{1}{C}\left(n_b - \frac{\sum_b N_b n_b - CB}{\sum_b N_b}\right),$$

where L_b denotes the number of bits allocated to each sample in a bth frequency band, C denotes a dB scale value, n_b denotes a Norm value dequantized by a log scale in the bth frequency band, N_b denotes the number of samples of the bth frequency band, and B denotes the total number of bits allowable in the given frame.

[Claim 5] The bit allocating method of claim 1, wherein the adjusting of the allocated number of bits comprises, if the allocated number of bits in each sample included in the predetermined frequency band is less than 0, allocating 0 to the allocated number of bits.

[Claim 6] The bit allocating method of claim 5, wherein the adjusting of the allocated number of bits comprises redistributing bits to each frequency band until a sum of the allocated numbers of bits determined for frequency bands included in the given frame is the same as the total number of bits allowable in the given frame.

[Claim 7] The bit allocating method of claim 1, wherein the adjusting of the

allocated number of bits comprises defining the minimum number of bits required for the predetermined frequency band and limiting the allocated number of bits to the minimum number of bits for a frequency band for which the allocated number of bits is less than the minimum number of bits.

[Claim 8] The bit allocating method of claim 1, wherein the adjusting of the allocated number of bits comprises defining the minimum number of bits required for the predetermined frequency band and setting the allocated number of bits to 0 for a frequency band for which the allocated number of bits is less than the minimum number of bits.

[Claim 9] The bit allocating method of claim 7 or 8, wherein the minimum number of bits is defined by using the number of bits required to encode at least one pulse in the predetermined frequency band.

[Claim 10] The bit allocating method of claim 7 or 8, wherein the adjusting of the allocated number of bits comprises redistributing bits to each frequency band until a sum of results adjusted by using the minimum number of bits for the frequency bands included in the given frame is the same as the total number of bits allowable in the given frame.

[Claim 11] A non-transitory computer-readable recording medium storing a computer-readable program for executing the method of claim 1.

[Claim 12] A bit allocating apparatus comprising:
a transform unit that transforms an audio signal in a time domain to an audio spectrum in a frequency domain; and
a bit allocating unit that estimates the allowable number of bits in decimal point units by using a masking threshold based on frequency bands included in a given frame in the audio spectrum, estimates the allocated number of bits in decimal point units by using spectral energy, and adjusts the allocated number of bits not to exceed the allowable number of bits.

[Claim 13] The bit allocating apparatus of claim 12, wherein the bit allocating unit distributes, based on a magnitude of spectral energy of the frequency bands included in the given frame, bits remaining as a result of limiting the allocated number of bits not to exceed the allowable number of bits based on frequency bands.

[Claim 14] The bit allocating apparatus of claim 12, wherein the spectral energy of each frequency band is weighted according to perceptual importance.

[Claim 15] An audio encoding apparatus comprising:
a transform unit that transforms an audio signal in a time domain to an

audio spectrum in a frequency domain;
a bit allocating unit that determines the allocated number of bits in decimal point units based on each frequency band so that a Signal-to-Noise Ratio (SNR) of a spectrum existing in a predetermined frequency band is maximized within a range of the allowable number of bits for a given frame of the audio spectrum and adjusts the allocated number of bits determined based on each frequency band; and
an encoding unit that encodes the audio spectrum by using the number of bits adjusted based on each frequency band and spectral energy.

[Claim 16] The audio encoding apparatus of claim 15, further comprising a transient detecting unit that detects an interval having a transient characteristic from the audio signal in the time domain to determine a window size used for the time-domain to frequency-domain transform by using the detected interval.

[Claim 17] An audio encoding apparatus comprising:
a transform unit that transforms an audio signal in a time domain to an audio spectrum in a frequency domain;
a bit allocating unit that estimates the allowable number of bits in decimal point units by using a masking threshold based on frequency bands included in a given frame in the audio spectrum, estimates the allocated number of bits in decimal point units by using spectral energy, and adjusts the allocated number of bits not to exceed the allowable number of bits; and
an encoder for encoding the audio spectrum by using the number of bits adjusted based on each frequency band and spectral energy.

[Claim 18] The audio encoding apparatus of claim 17, further comprising a transient detecting unit that detects an interval having a transient characteristic from the audio signal in the time domain to determine a window size used for the time-domain to frequency-domain transform by using the detected interval.

[Claim 19] An audio decoding apparatus comprising:
a bit allocating unit that determines the allocated number of bits in decimal point units based on each frequency band so that a Signal-to-Noise Ratio (SNR) of a spectrum existing in each frequency band is maximized within a range of the allowable number of bits for a given frame and adjusts the allocated number of bits determined based on each frequency band;
a decoding unit that decodes an audio spectrum included in a bitstream

by using the number of bits adjusted based on each frequency band and spectral energy; and

an inverse transform unit that transforms the decoded audio spectrum to an audio signal in a time domain.

[Claim 20] The audio decoding apparatus of claim 19, wherein a window size used in the inverse transform unit is set based on transient signaling information included in the bitstream.

[Claim 21] The audio decoding apparatus of claim 19, wherein the decoding unit generates a noise component for a frequency band including a part encoded to 0 and adjusts energy of the noise component by using a noise level.

[Claim 22] The audio decoding apparatus of claim 19, wherein the decoding unit generates a noise component for a frequency band including a part encoded to 0 and adjusts energy of the noise component by using a ratio of the energy of the noise component to the spectral energy.

[Claim 23] The audio decoding apparatus of claim 19, wherein the decoding unit generates a noise component for a frequency band including a part encoded to 0 and adjusts average energy of the noise component to be 1.

[Claim 24] An audio decoding apparatus comprising:

a bit allocating unit that estimates the allowable number of bits in decimal point units by using a masking threshold based on frequency bands included in a given frame, estimates the allocated number of bits in decimal point units by using spectral energy, and adjusts the allocated number of bits not to exceed the allowable number of bits;

a decoding unit that decodes an audio spectrum included in a bitstream by using the number of bits adjusted based on each frequency band and spectral energy; and

an inverse transform unit that transforms the decoded audio spectrum to an audio signal in a time domain.

[Claim 25] The audio decoding apparatus of claim 24, wherein a window size used in the inverse transform unit is set based on transient signaling information included in the bitstream.

[Claim 26] The audio decoding apparatus of claim 24, wherein the decoding unit generates a noise component for a frequency band including a part encoded to 0 and adjusts energy of the noise component by using a noise level.

[Claim 27] The audio decoding apparatus of claim 24, wherein the decoding unit

generates a noise component for a frequency band including a part encoded to 0 and adjusts energy of the noise component by using a ratio of the energy of the noise component to the spectral energy.

[Claim 28] The audio decoding apparatus of claim 24, wherein the decoding unit generates a noise component for a frequency band including a part encoded to 0 and adjusts average energy of the noise component to be 1.

Claims

1. A bit allocating method comprising:
receiving an audio signal;
generating an audio spectrum by transforming the audio signal from a time domain to a frequency domain;
fractionally estimating, by using a processor, bits to be allocated to a sub- band in a frame of the audio spectrum, in consideration of allowable bits for the frame, wherein the estimated bits are set to zero when the estimated bits of the sub- band are less than zero;
when the estimated bits of the sub-band are non-zero bits, re-distributing the estimated bits to the sub-band with non-zero bits, to allocate the bits to the sub- band;
quantizing spectral data of the sub-band using the allocated bits; and
outputting a bitstream generated based on the quantized spectral data.

2. The method of claim **1**, wherein the estimating is performed based on spectral energy of the sub-band.

3. The method of claim **1**, wherein the estimating is performed by using the equation below

$$L_b = \frac{1}{C}\left(n_b - \frac{\sum_b N_b n_b - CB}{\sum_b N_b}\right),$$

where L_b denotes bits allocated to each sample in a bth sub-band, C denotes a dB scale value, n_b denotes a Norm value dequantized by a log scale in the bth sub-band, N_b denotes samples of the bth sub-band, and B denotes the allowable bits for the frame.

4. The method of claim **1**, wherein the re-distributing comprises setting the allocated bits to zero when the allocated bits are less than predetermined minimum bits set to the sub-band.

5. The method of claim **1**, wherein the re-distributing comprises limiting the allocated bits, based on predetermined minimum bits set to the sub-band.

6. The method of claim 1, wherein the re-distributing comprises setting the allocated bits to predetermined minimum bits set to the sub-band, when the allocated bits are less than the predetermined minimum bits.

7. A non-transitory computer-readable recording medium storing a computer-readable program for executing a bit allocating method comprising:

receiving an audio signal;

generating an audio spectrum by transforming the audio signal from a time domain to a frequency domain;

fractionally estimating, by using a processor, bits to be allocated to a sub-band in a frame of the audio spectrum, in consideration of allowable bits for the frame, wherein the estimated bits are set to zero when the estimated bits of the sub-band are less than zero;

when the estimated bits of the sub-band are non-zero bits, re-distributing the estimated bits to the sub-band with non-zero bits, to allocate the bits to the sub-band;

quantizing spectral data of the sub-band using the allocated bits; and

outputting a bitstream generated based on the quantized spectral data.

8. A bit allocating apparatus comprising:

a processor configured:

to receive an audio signal;

to generate an audio spectrum by transforming the audio signal from a time domain to a frequency domain;

to fractionally estimate bits to be allocated to a sub-band in a frame of the audio spectrum, in consideration of allowable bits for the frame, wherein the estimated bits are set to zero when the estimated bits of the sub-band are less than zero; and

when the estimated bits of the sub-band are non-zero bits, to allocate the bits to the sub-band by re-distributing the estimated bits to the sub-band with non-zero bits;

to quantize spectral data of the sub-band using the allocated bits; and

to output a bitstream generated based on the quantized spectral data.

9. An audio encoding apparatus comprising:

a transform unit configured to generate an audio spectrum by transforming an audio signal from a time domain to a frequency domain;

a bit allocating unit configured to fractionally estimate bits to be allocated to a sub-band in a frame of the audio spectrum, in consideration of allowable bits for the frame, wherein the estimated bits are set to zero when the estimated bits of the sub-band are less than zero and when the estimated bits of the sub-band are non-zero bits, to allocate the bits to the sub-band by re-distributing the estimated bits to the sub-band with non-zero bits; and

an encoding unit configured to encode the frame by quantizing spectral data based on the allocated bits for the sub-band, and to output a bitstream generated based on the quantized spectral data.

10. An audio decoding apparatus comprising:

a bit allocating unit configured to fractionally estimate bits to be allocated to a sub-band in a frame of a bitstream, in consideration of allowable bits for the frame, wherein the estimated bits are set to zero when the estimated bits of the sub-band are less than zero and when the estimated bits of the sub-band are non-zero bits, to allocate the bits to the sub-band by re-distributing the estimated bits to the sub-band with non-zero bits; and

a decoding unit configured to decode the frame by dequantizing the frame based on the allocated bits for the sub-band;

an inverse transform unit configured to generate a reconstructed audio signal by transforming the dequantized frame into a time domain.

11. The method of claim **1**, wherein the re-distributing is performed based on the allocated bits for higher bands.

12. The apparatus of claim **9**, wherein the bit allocation unit is based on spectral energy of the sub-band.

13. The apparatus of claim **9**, wherein the bit allocation unit is configured to limit the allocated bits, based on predetermined minimum bits set to the sub-band.

14. The apparatus of claim **9**, wherein the bit allocation unit is configured to set the allocated bits to zero when the allocated bits are less than predetermined minimum bits set to the sub-band.

15. The apparatus of claim **9**, wherein the bit allocation unit is configured to set the allocated bits to predetermined minimum bits set to the sub-band, when the allocated bits are less than the predetermined minimum bits.

16. The apparatus of claim **9**, wherein the bit allocation unit is based on the allocated bits for higher bands.

17. The apparatus of claim **10**, wherein the bit allocation unit is based on spectral energy of the sub-band.

18. The apparatus of claim **10**, wherein the bit allocation unit is configured to limit the allocated bits, based on predetermined minimum bits set to the sub-band.

19. The apparatus of claim **10**, wherein the bit allocation unit is configured to set the allocated bits to zero when the allocated bits are less than predetermined minimum bits set to the sub-band.

20. The apparatus of claim **10**, wherein the bit allocation unit is configured to set the allocated bits to predetermined minimum bits set to the sub-band, when the allocated bits are less than the predetermined minimum bits.

21. The apparatus of claim **10**, wherein the bit allocation unit is based on the allocated bits for higher bands.