Claims

[Claim 1] A quantizing apparatus comprising:
a quantization path determination unit that determines one of a plurality of paths comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a quantization path of an input signal, based on a criterion before quantization of the input signal;
a first quantization unit that quantizes the input signal, if the first path is determined as the quantization path of the input signal; and
a second quantization unit that quantizesthe input signal, if the second path is determined as the quantization path of the input signal.

[Claim 2] The quantizing apparatus of claim 1, wherein the first quantization unit comprises a first quantizer to roughly quantize the input signal and a second quantizer to precisely quantize a quantization error signal between the input signal and an output signal of the first quantizer.

[Claim 3] The quantizing apparatus of claim 1, wherein the first quantization unit comprises a Multi-Stage Vector Quantizer (MSVQ) for quantizing the input signal, and a Lattice Multi-Stage Vector Quantizer (LVQ) for quantizing an error signal indicating an error determined between the input signal and an output signal of the MSVQ.

[Claim 4] The quantizing apparatus of claim 1, wherein the second quantization unit comprises an inter-frame predictor that performs the inter-frame prediction of the input signal, and a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that quantizes predictive errors.

[Claim 5] The quantizing apparatus of claim 4, wherein the BC-TCQ determines a quantization index by using weighted distortion.

[Claim 6] The quantizing apparatus of claim 1, wherein the criterion comprises at least one of a prediction mode and a predictive error according to a characteristic of the input signal.

[Claim 7] The quantizing apparatus of claim 6, wherein the criterion further comprises a transmission channel state.

[Claim 8] The quantizing apparatus of claim 6, wherein the criterion further comprises at least one of a coding bit rate, a bandwidth of the input signal and an internal sampling frequency.

[Claim 9] The quantizing apparatus of claim 6, wherein the predictive error is obtained by using a signal of a current frame, a signal of a previous

frame, and a weighting function related to an importance of the input signal.

[Claim 10] The quantizing apparatus of claim 9, wherein the weighting function is determined by using at least one of a frequency band of the input signal, a coding mode, and spectrum analysis information.

[Claim 11] The quantizing apparatus of claim 6, wherein, when the input signal is non-stationary, the first path is selected.

[Claim 12] The quantizing apparatus of claim 6, wherein, when the input signal is stationary, one of the first path and the second path is selected based on the predictive error.

[Claim 13] The quantizing apparatus of claim 1, wherein the quantization path determination unit performs:

determining a prediction mode of the input signal;

selecting the first path or the second path as the quantization path of the input signal by using the prediction mode of the input signal;

if the quantization path of the input signal is not determined by using the prediction mode of the input signal, comparing a first predictive error obtained from a current frame and a previous frame with a first threshold; and

if the first predictive error is greater than or equal to the first threshold, selecting the first path as the quantization path of the input signal, and if the first predictive error is not greater than or equal to the first threshold, selecting the second path as the quantization path of the input signal.

[Claim 14] The quantizing apparatus of claim 13, wherein the quantization path determination unit further performs:

if an error occurs in the previous frame, comparing a second predictive error obtained from the current frame and the previous frame with a second threshold; and

if the second predictive error is greater than or equal to the second threshold, selecting the first path as the quantization path of the input signal, and if the second predictive error is not greater than or equal to the second threshold, selecting the second path as the quantization path of the input signal.

[Claim 15] A quantizing apparatus comprising:

a quantization path determination unit that determines one of a plurality of paths, comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a quantization path of

Linear Predictive Coding (LPC) coefficients based on a criterion before quantization of the LPC coefficients;

a first quantization unit that quantizes the LPC coefficients, if the first path is determined as the quantization path of the LPC coefficients; and

a second quantization unit that quantizes the LPC coefficients, if the second path is determined as the quantization path of the LPC coefficients,

wherein the first quantization unit comprises a Multi-Stage Vector Quantizer (MSVQ) for quantizing the LPC coefficients, and a Lattice Multi-Stage Vector Quantizer (LVQ) for quantizing errors between the LPC coefficients and an output of the MSVQ, and

the second quantization unit comprises an inter-frame predictor for performing the inter-frame prediction of the LPC coefficients, and a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor for quantizing predictive errors.

[Claim 16] A de-quantizing apparatus comprising:

a de-quantization path determination unit that determines one of a plurality of paths comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a de-quantization path of Linear Predictive Coding (LPC) parameters based on quantization path information included in a bitstream;

a first de-quantization unit that de-quantizes the LPC parameters, if the first path is determined as the de-quantization path of the LPC parameters; and

a second de-quantization unit that de-quantizes the LPC parameters, if the second path is selected as the de-quantization path of the LPC parameters,

wherein the quantization path information is determined based on a criterion before quantization of an input signal in an encoding end.

[Claim 17] The de-quantizing apparatus of claim 16, wherein the first de-quantization unit comprises a first de-quantizer that roughly de-quantizes the LPC parameters and a second de-quantizer that precisely de-quantizes the LPC parameters.

[Claim 18] A de-quantizing apparatus comprising:

a de-quantization path determination unit that determines one of a plurality of paths comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a de-quantization path of Linear Predictive Coding (LPC) parameters based

on quantization path information included in a bitstream;
a first de-quantization unit that de-quantizes the LPC parameters, if the first path is determined as the de-quantization path of the LPC parameters; and
a second de-quantization unit that de-quantizes the LPC parameters, if the second path is determined as the de-quantization path of the LPC parameters,
wherein the first de-quantization unit comprises a Multi-Stage Vector Quantizer (MSVQ) that de-quantizes the LPC parameters by using a first codebook index, and a Lattice Multi-Stage Vector Quantizer (LVQ) that de-quantizes the LPC parameters by using a second codebook index, and
the second de-quantization unit comprises a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that de-quantizes the LPC parameters by using a third codebook index and an inter-frame predictor.

[Claim 19] An encoding apparatus comprising:
a coding mode determination unit that determines a coding mode of an input signal;
a quantization unit that determines one of a plurality of paths comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a quantization path of the input signal based on a criterion before quantization of the input signal and quantize the input signal by using one of a first quantization scheme and a second quantization scheme according to the determined quantization path;
a variable mode encoding unit that encodes the quantized input signal in the coding mode; and
a parameter encoding unit that generates a bitstream including one of a result quantized in the first quantization unit and a result quantized in the second quantization unit, the coding mode of the input signal, and path information related to the quantization of the input signal.

[Claim 20] A decoding apparatus comprising:
a parameter decoding unit that decodes Linear Predictive Coding (LPC) parameters and a coding mode included in a bitstream;
a de-quantization unit that de-quantizes the decoded LPC parameters by using one of a first de-quantization scheme not using inter-frame prediction and a second de-quantization scheme using the inter-frame

prediction based on quantization path information included in the bitstream; and

a variable mode decoding unit that decodes the de-quantized LPC parameters in the decoded coding mode,

wherein the quantization path information is determined based on a criterion before quantization of an input signal in an encoding end.

[Claim 21] The decoding apparatus of claim 20, wherein the first de-quantization scheme comprises a Multi-Stage Vector Quantizer (MSVQ) that de-quantizes the LPC parameters by using a first codebook index, and a Lattice Multi-Stage Vector Quantizer (LVQ) that de-quantizes the LPC parameters by using a second codebook index.

[Claim 22] The decoding apparatus of claim 20, wherein the second de-quantization scheme comprises a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that de-quantizes the LPC parameters by using a third codebook index and an inter-frame predictor.

[Claim 23] A decoding apparatus comprising:

a parameter decoding unit that decodes Linear Predictive Coding (LPC) parameters and a coding mode included in a bitstream;

a de-quantization unit that de-quantizes the decoded LPC parameters by using one of a first de-quantization scheme not using inter-frame prediction and a second de-quantization scheme using the inter-frame prediction based on quantization path information included in the bitstream; and

a variable mode decoding unit that decodes the de-quantized LPC parameters in the decoded coding mode,

wherein the first de-quantization scheme comprises a Multi-Stage Vector Quantizer (MSVQ) that de-quantizes the LPC parameters by using a first codebook index, and a Lattice Multi-Stage Vector Quantizer (LVQ) that de-quantizes the LPC parameters by using a second codebook index, and

the second de-quantization scheme comprises a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that de-quantizes the LPC parameters by using a third codebook index and an inter-frame predictor.

[Claim 24] A quantizing apparatus comprising:

a first quantization unit that quantizes an input signal by using a first quantization scheme not using inter-frame prediction;

a second quantization unit that quantizes the input signal by using a second quantization scheme using the inter-frame prediction; and

a quantization path determination unit that selects one of outputs of the first quantization scheme and the second quantization scheme by using quantized distortion obtained by the first quantization scheme and quantized distortion obtained by the second quantization scheme,

wherein the first quantization scheme comprises a Multi-Stage Vector Quantizer (MSVQ) that quantizes the input signal, and a Lattice Multi-Stage Vector Quantizer (LVQ) that quantizes an error signal between the input signal and an output signal of the MSVQ, and

the second quantization scheme comprises an inter-frame predictor that performs the inter-frame prediction of the input signal, and a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that quantizes predictive errors.

[Claim 25] An electronic device comprising:

a communication unit that receives at least one of a sound signal and an encoded bitstream, or that transmits at least one of an encoded sound signal and a restored sound; and

an encoding module that selects one of a plurality of paths comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a quantization path of the received sound signal based on a criterion before quantization of the received sound signal, quantizes the received sound signal by using one of a first quantization scheme and a second quantization scheme according to the selected quantization path, and encodes the quantized sound signal in a coding mode.

[Claim 26] The electronic device of claim 25, wherein the first quantization scheme comprises a first quantizer that roughly quantizes the received sound signal, and a second quantizer that precisely quantizes a quantization error signal between the received sound signal and an output signal of the first quantizer.

[Claim 27] The electronic device of claim 25, wherein the first quantization scheme comprises a Multi-Stage Vector Quantizer (MSVQ) that quantizes the received sound signal, and a Lattice Multi-Stage Vector Quantizer (LVQ) that quantizes an error signal between the received sound signal and an output signal of the MSVQ.

[Claim 28] The electronic device of claim 25, wherein the second quantization scheme comprises an inter-frame predictor that performs the inter-

frame prediction of the received sound signal, and a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that quantizes predictive errors.

[Claim 29] An electronic device comprising:
a communication unit that receives at least one of a sound signal and an encoded bitstream, or that transmits at least one of an encoded sound signal and a restored sound; and
a decoding module that decodes Linear Predictive Coding (LPC) parameters and a coding mode included in the bitstream, de-quantizes the decoded LPC parameters by using one of a first de-quantization scheme not using inter-frame prediction and a second de-quantization scheme using the inter-frame prediction based on path information included in the bitstream, and decodes the de-quantized LPC parameters in the decoded coding mode,
wherein the path information is determined based on a criterion before quantization of the sound signal in an encoding end.

[Claim 30] The electronic device of claim 29, wherein the first de-quantization scheme comprises a first de-quantizer that roughly de-quantizes the LPC parameters, and a second de-quantizer that precisely de-quantizes the LPC parameters.

[Claim 31] The electronic device of claim 29, wherein the first de-quantization scheme comprises a Multi-Stage Vector Quantizer (MSVQ) that de-quantizes the LPC parameters by using a first codebook index, and a Lattice Multi-Stage Vector Quantizer (LVQ) that de-quantizes the LPC parameters by using a second codebook index.

[Claim 32] The electronic device of claim 29, wherein the second de-quantization scheme comprises a Block-Constrained Trellis-Coded Quantizer (BC-TCQ) having an intra-frame predictor that de-quantizes the LPC parameters by using a third codebook index and an inter-frame predictor.

[Claim 33] An electronic device comprising:
a communication unit that receives at least one of a sound signal and an encoded bitstream, or that transmits at least one of an encoded sound signal and a restored sound;
an encoding module that selects one of a plurality of paths comprising a first path not using inter-frame prediction and a second path using the inter-frame prediction, as a quantization path of the received sound signal based on a criterion before quantization of the received sound

signal, quantizes the received sound signal by using one of a first quantization scheme and a second quantization scheme according to the selected quantization path, and encodes the quantized sound signal in a coding mode; and

a decoding module that decodes Linear Predictive Coding (LPC) parameters and a coding mode included in the bitstream, de-quantizes the decoded LPC parameters by using one of a first de-quantization scheme not using the inter-frame prediction and a second de-quantization scheme using the inter-frame prediction based on path information included in the bitstream, and decodes the de-quantized LPC parameters in the decoded coding mode.

[Claim 34] The electronic device of claim 33, wherein the first quantization scheme comprises a first quantizer that roughly quantizes the received sound signal and a second quantizer that precisely quantizes a quantization error signal between the received sound signal and an output signal of the first quantizer.

[Claim 35] An electronic device comprising:

a communication unit that receives at least one of a sound signal and an encoded bitstream, or that transmits at least one of an encoded sound signal and a restored sound; and

an encoding module that quantizes the received sound signal by selecting one of a first quantization scheme not using an inter-frame prediction and a second quantization scheme using the inter-frame prediction according to path information determined in consideration of at least one of a prediction mode, a predictive error and a transmission channel state, and that encodes the quantized sound signal in a coding mode.

[Claim 36] The electronic device of claim 35, wherein the first quantization scheme comprises a first quantizer that roughly quantizes the received sound signal and a second quantizer that precisely quantizes a quantization error signal between the received sound signal and an output signal of the first quantizer.

[Claim 37] An electronic device comprising:

a communication unit that receives at least one of a sound signal and an encoded bitstream, or that transmits at least one of an encoded sound signal and a restored sound; and

a decoding module that decodes Linear Predictive Coding (LPC) parameters and a coding mode included in the bitstream, de-quantizes the

decoded LPC parameters by using one of a first de-quantization scheme not using inter-frame prediction and a second de-quantization scheme using the inter-frame prediction based on path information included in the bitstream, and decodes the de-quantized LPC parameters in the decoded coding mode,

wherein the path information is determined in consideration of at least one of a prediction mode, a predictive error and a transmission channel state in an encoding end.

[Claim 38] The electronic device of claim 37, wherein the first de-quantization scheme comprises a first de-quantizer that roughly de-quantizes the LPC parameters and a second de-quantizer that precisely de-quantizes the LPC parameters.

[Claim 39] An electronic device comprising:

a communication unit that receives at least one of a sound signal and an encoded bitstream, or that transmits at least one of an encoded sound signal and a restored sound;

an encoding module that quantizes the received sound signal by selecting one of a first quantization scheme not using an inter-frame prediction and a second quantization scheme using the inter-frame prediction, according to path information determined in consideration of at least one of a prediction mode, a predictive error and a transmission channel state, and that encodes the quantized sound signal in a coding mode; and

a decoding module that decodes Linear Predictive Coding (LPC) parameters and a coding mode included in the bitstream, de-quantizes the decoded LPC parameters by using one of a first de-quantization scheme not using inter-frame prediction and a second de-quantization scheme using the inter-frame prediction based on path information included in the bitstream, and decodes the de-quantized LPC parameters in the decoded coding mode.

[Claim 40] The electronic device of claim 39, wherein the first quantization scheme comprises a first quantizer that roughly quantizes the received sound signal and a second quantizer that precisely quantizes a quantization error signal between the received sound signal and an output signal of the first quantizer.

Claims

1. A quantizing apparatus comprising:

a selector configured to select, based on a predictive error, one of a first quantization module and a second quantization module, in an open-loop manner;

the first quantization module, implemented by a processor, configured to quantize an input signal, without inter-frame prediction; and

the second quantization module configured to quantize the input signal, with inter-frame prediction.

2. The quantizing apparatus of claim **1**, wherein the first quantization module comprises a trellis-structured quantizer with block constraints and an intra-frame predictor.

3. The quantizing apparatus of claim **2**, wherein the trellis-structured quantizer with block constraints is configured to search for an index based on a weighting function.

4. The quantizing apparatus of claim **1**, wherein the second quantization module comprises a trellis-structured quantizer with block constraints, an intra-frame predictor and an inter-frame predictor.

5. The quantizing apparatus of claim **4**, wherein the trellis-structured quantizer with block constraints is configured to search for an index based on a weighting function.

6. The quantizing apparatus of claim **1**, wherein the first quantization module comprises a first trellis-structured quantizer with block constraints and an intra-frame predictor, and the second quantization module comprises a second trellis-structured quantizer with block constraints, an intra-frame predictor and an inter-frame predictor.

7. The quantizing apparatus of claim **6**, wherein the first and second trellis-structured quantizers with block constraints are configured to search for an index based on a weighting function.

8. The quantizing apparatus of claim **1**, wherein the predictive error is based on a weighting function.

9. The quantizing apparatus of claim **1**, wherein the predictive error is based on at least one of linear spectral frequency (LSF) coefficients of a current frame, LSF coefficients of a previous frame, auto-regressive prediction coefficients, and a weighting function related to signal characteristics.

10. The quantizing apparatus of claim **1**, wherein the predictive error is based on a weighting function, wherein the weighting function is determined based on at least one of a bandwidth, a coding mode, and spectrum analysis information of the input signal.

11. The quantizing apparatus of claim **1**, wherein a coding mode of the input signal is a generic coding mode.

12. The quantizing apparatus of claim **1**, wherein a coding mode of the input signal is a voiced coding mode.

13. The quantizing apparatus of claim **1**, wherein the predictive error Ep is obtained by an equation:

$$E_p=\Sigma_{i=0}^{M-1} w_{end}(i)(z_k(i)-z_{k-1}(i)p(i))^2,$$

where M denotes a dimension of linear spectral frequency (LSF) coefficients, $z_k(i)$ denotes an i^{th} LSF coefficient of a k^{th} frame, $z_{k-1}(i)$ denotes an i^{th} LSF coefficient of a $(k-1)^{th}$ frame, p(i) denotes an i^{th} auto-regressive prediction coefficient, and $w_{end}(i)$ denotes an i^{th} weight.

14. The quantizing apparatus of claim **1**, wherein the selector is configured to compare the predictive error with a threshold, to select the first quantization module if the predictive error is greater than the threshold and to select the second quantization module if the predictive error is less than or equal to the threshold.

15. The quantizing apparatus of claim **14**, wherein the threshold is a fixed value.

16. The quantizing apparatus of claim **14**, wherein the threshold is a variable value.

17. The quantizing apparatus of claim **1**, wherein the selector is configured to select the first quantization module if the input signal is non-stationary.

18. The quantizing apparatus of claim **1**, wherein the first quantization module comprises a trellis-structured quantizer with block constraints, an intra-frame predictor and a vector quantizer.

19. The quantizing apparatus of claim **1**, wherein the second quantization module comprises a trellis-structured quantizer with block constraints, an intra-frame predictor, an inter-frame predictor and a vector quantizer.

20. The quantizing apparatus of claim **1**, wherein the first quantization module comprises a first trellis-structured quantizer with block constraints, an intra-frame predictor and a first vector quantizer, and the second quantization module comprises a second trellis-structured quantizer with block constraints, an intra-frame predictor, an inter-frame predictor and a second vector quantizer.