Claims

1. Audio decoder for decoding an encoded multi-channel audio signal ~~(100)~~, the encoded multi-channel audio signal comprising an encoded first combination signal generated based on a combination rule for combining a first channel audio signal and a second channel audio signal of a multi-channel audio signal, an encoded prediction residual signal and prediction information, comprising:

a signal decoder ~~(110)~~ for decoding the encoded first combination signal ~~(104)~~ to obtain a decoded first combination signal ~~(112)~~, and for decoding the encoded residual signal ~~(106)~~ to obtain a decoded residual signal ~~(114)~~; and

a decoder calculator ~~(116)~~ for calculating a decoded multi-channel signal having a decoded first channel signal ~~(117)~~, and a decoded second channel signal ~~(118)~~ using the decoded residual signal ~~(114)~~, the prediction information ~~(108)~~ and the decoded first combination signal ~~(112)~~, so that the decoded first channel signal ~~(117)~~ and the decoded second channel signal ~~(118)~~ are at least approximations of the first channel signal and the second channel signal of the multi-channel signal, wherein the prediction information ~~(108)~~ comprises a real-valued portion different from zero and/or an imaginary portion different from zero,

wherein the prediction information ~~(108)~~ comprises an imaginary factor different from zero,

wherein the decoder calculator ~~(116)~~ comprises a predictor ~~(1160)~~ configured for estimating ~~(1160a)~~ an imaginary part of the decoded first combination signal ~~(112)~~ using a real part of the decoded first combination signal ~~(112)~~,

wherein the predictor ~~(1160)~~ is configured for multiplying the imaginary part ~~(601)~~ of the decoded first combination signal by the imaginary factor of the prediction information ~~(108)~~ when obtaining a prediction signal;

wherein the decoder calculator ~~(116)~~ further comprises a combination signal calculator ~~(1161)~~ configured for linearly combining the prediction signal and the decoded residual signal to obtain a second combination signal ~~(1165)~~; and

wherein the decoder calculator ~~(116)~~ further comprises a combiner ~~(1162)~~ for combining the second combination signal ~~(1165)~~ and the decoded first combination

signal to obtain the decoded first channel signal ~~(117)~~, and the decoded second channel signal ~~(118)~~.

2. Audio decoder of claim 1, in which the decoder calculator ~~(116)~~ comprises:

a predictor ~~(1160)~~ for applying the prediction information ~~(108)~~ to the decoded first combination signal ~~(112)~~ or to a signal ~~(601)~~ derived from the decoded first combination signal to obtain a prediction signal ~~(1163)~~;

a combination signal calculator ~~(1161)~~ for calculating a second combination signal ~~(1165)~~ by combining the decoded residual signal ~~(114)~~ and the prediction signal ~~(1163)~~; and

a combiner ~~(1162)~~ for combining the decoded first combination signal ~~(112)~~ and the second combination signal ~~(1165)~~ to obtain a decoded multi-channel audio signal having the decoded first channel signal ~~(117)~~ and the decoded second channel signal ~~(118)~~.

3. Audio decoder in accordance with claim 1 or 2,

in which the encoded first combination signal ~~(104)~~ and the encoded residual signal ~~(106)~~ have been generated using an aliasing generating time-spectral conversion,

wherein the decoder further comprises:

a spectral-time converter ~~(52, 53)~~ for generating a time-domain first channel signal and a time-domain second channel signal using a spectral-time conversion algorithm matched to the time-spectral conversion algorithm;

an overlap/add processor ~~(522)~~ for conducting an overlap-add processing for the time-domain first channel signal and for the time-domain second channel signal to obtain an aliasing-free first time-domain signal and an aliasing-free second time-domain signal.

4. Audio decoder in accordance with one of the preceding claims, in which the prediction information ~~(108)~~ comprises a real factor different from zero,

in which the predictor ~~(1160)~~ is configured for multiplying the decoded first combination signal by the real factor to obtain a first part of the prediction signal, and

in which the combination signal calculator is configured for linearly combining the decoded residual signal and the first part of the prediction signal.

5. Audio decoder in accordance with one of the preceding claims,

in which the encoded or decoded first combination signal ~~(104)~~ and the encoded or decoded prediction residual signal ~~(106)~~ each comprises a first plurality of subband signals,

wherein the prediction information comprises a second plurality of prediction information parameters, the second plurality being smaller than the first plurality,

wherein the predictor ~~(1160)~~ is configured for applying the same prediction parameter to at least two different subband signals of the decoded first combination signal,

wherein the decoder calculator ~~(116)~~ or the combination signal calculator ~~(1161)~~ or the combiner ~~(1162)~~ are configured for performing a subband-wise processing; and

wherein the audio decoder further comprises a synthesis filterbank ~~(52, 53)~~ for combining subband signals of the decoded first combination signal and the decoded second combination signal to obtain a time-domain first decoded signal and a time-domain second decoded signal.

6. Audio decoder in accordance with claim 2,

in which the predictor ~~(1160)~~ is configured for filtering at least two time-subsequent frames, where one of the two time-subsequent frames precedes or follows a current frame of the first combination signal to obtain an estimated imaginary part of a current frame of the first combination signal using a linear filter ~~(1004, 1005, 1006, 1007)~~.

7. Audio decoder in accordance with claim 2,

in which the decoded first combination signal comprises a sequence of real-valued signal frames, and

in which the predictor ~~(1160)~~ is configured for estimating ~~(1160a)~~ an imaginary part of the current signal frame using only the current real-valued signal frame or using the

current real-valued signal frame and either only one or more preceding or only one or more following real-valued signal frames or using the current real-valued signal frame and one or more preceding real-valued signal frames and one or more following real-valued signal frames.

8. Audio decoder in accordance with claim 2, in which the predictor ~~(1160)~~ is configured for receiving window shape information ~~(109)~~ and for using different filter coefficients for calculating an imaginary spectrum, where the different filter coefficients depend on different window shapes indicated by the window shape information ~~(109)~~.

9. Audio decoder in accordance with claim 6, 7 or 8,

in which the decoded first combination signal is associated with different transform lengths indicated by a transform length indicator included in the encoded multi-channel signal ~~(100)~~, and

in which the predictor ~~(1160)~~ is configured for only using one or more frames of the first combination signal having the same associated transform length for estimating the imaginary part for a current frame for a first combination signal.

10. Audio decoder in accordance with one of claims 2 to 9,

in which the predictor ~~(1160)~~ is configured for using a plurality of subbands of the decoded first combination signal adjacent in frequency, for estimating the imaginary part of the first combination signal, and

wherein, in case of low or high frequencies, a symmetric extension in frequency of the current frame of the first combination signal is used for subbands associated with frequencies lower or equal to zero or higher or equal to a half of a sampling frequency on which the current frame is based, or in which filter coefficients of a filter included in the predictor ~~(1160a)~~ are set to different values for the missing subbands compared to non-missing subbands.

11. Audio decoder in accordance with one of the preceding claims,

in which the prediction information ~~(108)~~ is included in the encoded multi-channel signal in a quantized and entropy-encoded representation,

wherein the audio decoder further comprises a prediction information decoder ~~(65)~~ for entropy-decoding or dequantizing to obtain a decoded prediction information used by the predictor ~~(1160)~~, or

in which the encoded multi-channel audio signal comprises a data unit indicating in the first state that the predictor ~~(1160)~~ is to use at least one frame preceding or following in time to a current frame of the decoded first combination signal, and indicating in the second state that the predictor ~~(1160)~~ is to use only a single frame of the decoded first combination signal for an estimation of an imaginary part for the current frame of the decoded first combination signal, and in which the predictor ~~(1160)~~ is configured for sensing a state of the data unit and for operating accordingly.

12. Audio decoder in accordance with one of the preceding claims, in which the prediction information ~~(108)~~ comprises codewords of differences between time sequential or frequency adjacent complex values, and

wherein the audio decoder is configured for performing an entropy decoding step and a subsequent difference decoding step to obtain time sequential quantized complex prediction values or complex prediction values for adjacent frequency bands.

13. Audio decoder in accordance with one of claims 1 to 9, in which the encoded multi-channel signal comprises, as side information, a real indicator indicating that all prediction coefficients for a frame of the encoded multi-channel signal are real valued,

wherein the audio decoder is configured for extracting the real indicator from the encoded multi-channel audio signal ~~(100)~~, and

wherein the decoder calculator ~~(116)~~ is configured for not calculating an imaginary signal for a frame, for which the real indicator is indicating only real-valued prediction coefficients.

14. Audio encoder for encoding a multi-channel audio signal having two or more channel signals, comprising:

an encoder calculator ~~(203)~~ for calculating a first combination signal ~~(204)~~ and a prediction residual signal ~~(205)~~ using a first channel signal ~~(201)~~ and a second channel signal ~~(202)~~ and prediction information ~~(206)~~, so that a prediction residual signal, when combined with a prediction signal derived from the first combination signal or a

signal derived from the first combination signal and the prediction information ~~(206)~~ results in a second combination signal ~~(2032)~~, the first combination signal ~~(204)~~ and the second combination signal ~~(2032)~~ being derivable from the first channel signal ~~(201)~~ and the second channel signal ~~(202)~~ using a combination rule;

an optimizer ~~(207)~~ for calculating the prediction information ~~(206)~~ so that the prediction residual signal ~~(205)~~ fulfills an optimization target ~~(208)~~;

a signal encoder ~~(209)~~ for encoding the first combination signal ~~(204)~~ and the prediction residual signal ~~(205)~~ to obtain an encoded first combination signal ~~(210)~~ and an encoded residual signal ~~(211)~~; and

an output interface ~~(212)~~ for combining the encoded first combination signal ~~(210)~~, the encoded prediction residual signal ~~(211)~~ and the prediction information ~~(206)~~ to obtain an encoded multi-channel audio signal,

wherein the first channel signal is a spectral representation of a block of samples;

wherein the second channel signal is a spectral representation of a block of samples,

wherein the spectral representations are either pure real spectral representations or pure imaginary spectral representations,

wherein the optimizer ~~(207)~~ is configured for calculating the prediction information ~~(206)~~ as a real-valued factor different from zero and/or as an imaginary factor different from zero,

wherein the encoder calculator ~~(203)~~ comprises a real-to-imaginary transformer ~~(2070)~~ or an imaginary-to-real transformer for deriving a transform spectral representation from the first combination signal, and

wherein the encoder calculator ~~(203)~~ is configured to calculate the first combined signal ~~(204)~~ and the first residual signal ~~(2032)~~ so that the prediction signal is derived from the transformed spectrum using the imaginary factor.

15. Audio encoder in accordance with claim 15, in which the encoder calculator ~~(203)~~ comprises:

a combiner ~~(2031)~~ for combining the first channel signal ~~(201)~~ and the second channel signal ~~(202)~~ in two different ways to obtain the first combination signal ~~(204)~~ and the second combination signal ~~(2032)~~;

a predictor ~~(2033)~~ for applying the prediction information ~~(206)~~ to the first combination signal ~~(204)~~ or a signal ~~(600)~~ derived from the first combination signal ~~(204)~~ to obtain a prediction signal ~~(2035)~~; and

a residual signal calculator ~~(2034)~~ for calculating the prediction residual signal ~~(205)~~ by combining the prediction signal ~~(2035)~~ and the second combination signal ~~(2032)~~.

16. Audio encoder in accordance with claim 15, in which the predictor ~~(2033)~~ comprises a quantizer for quantizing the first channel signal, the second channel signal, the first combination signal or the second combination signal to obtain one or more quantized signals, and wherein the predictor ~~(2033)~~ is configured for calculating the residual signal using quantized signals.

17. Audio encoder in accordance with one of claims 14 to 16,

in which the first channel signal is a spectral representation of a block of samples;

in which the second channel signal is a spectral representation of a block of samples,

wherein the spectral representations are either pure real spectral representations or pure imaginary spectral representations,

in which the optimizer ~~(207)~~ is configured for calculating the prediction information ~~(206)~~ as a real-valued factor different from zero and/or as an imaginary factor different from zero, and

in which the encoder calculator ~~(203)~~ is configured to calculate the first combination signal and the prediction residual signal so that the prediction signal is derived from the pure real spectral representation or the pure imaginary spectral representation using the real-valued factor.

18. Encoder in accordance with one of claims 14 to 18,

in which the predictor ~~(2033)~~ is configured for multiplying the first combination signal ~~(204)~~ by a real part of the prediction information ~~(2073)~~ to obtain a first part of the prediction signal;

for estimating ~~(2070)~~ an imaginary part ~~(600)~~ of the first combination signal using the first combination signal ~~(204)~~;

for multiplying the imaginary part of the first combined signal by an imaginary part of the prediction information ~~(2074)~~ to obtain a second part of the prediction signal; and

wherein the residual calculator ~~(2034)~~ is configured for linearly combining the first part signal of the prediction signal or the second part signal of the prediction signal and the second combination signal to obtain the prediction residual signal ~~(205)~~.

19. Method of decoding an encoded multi-channel audio signal ~~(100)~~, the encoded multi-channel audio signal comprising an encoded first combination signal generated based on a combination rule for combining a first channel audio signal and a second channel audio signal of a multi-channel audio signal, an encoded prediction residual signal and prediction information, comprising:

decoding ~~(110)~~ the encoded first combination signal ~~(104)~~ to obtain a decoded first combination signal ~~(112)~~, and decoding the encoded residual signal ~~(106)~~ to obtain a decoded residual signal ~~(114)~~; and

calculating ~~(116)~~ a decoded multi-channel signal having a decoded first channel signal ~~(117)~~, and a decoded second channel signal ~~(118)~~ using the decoded residual signal ~~(114)~~, the prediction information ~~(108)~~ and the decoded first combination signal ~~(112)~~, so that the decoded first channel signal ~~(117)~~ and the decoded second channel signal ~~(118)~~ are at least approximations of the first channel signal and the second channel signal of the multi-channel signal, wherein the prediction information ~~(108)~~ comprises a real-valued portion different from zero and/or an imaginary portion different from zero,

wherein the prediction information ~~(108)~~ comprises an imaginary factor different from zero,

wherein an imaginary part of the decoded first combination signal ~~(112)~~ is estimated ~~(1160a)~~ using a real part of the decoded first combination signal ~~(112)~~,

wherein the imaginary part (601) of the decoded first combination signal is multiplied by the imaginary factor of the prediction information (108) when obtaining a prediction signal;

wherein the prediction signal and the decoded residual signal are linearly combined to obtain a second combination signal (1165); and

wherein the second combination signal (1165) and the decoded first combination signal are combined to obtain the decoded first channel signal (117), and the decoded second channel signal (118).

20. Method of encoding a multi-channel audio signal having two or more channel signals, comprising:

calculating (203) a first combination signal (204) and a prediction residual signal (205) using a first channel signal (201) and a second channel signal (202) and prediction information (206), so that a prediction residual signal, when combined with a prediction signal derived from the first combination signal or a signal derived from the first combination signal and the prediction information (206) results in a second combination signal (2032), the first combination signal (204) and the second combination signal (2032) being derivable from the first channel signal (201) and the second channel signal (202) using a combination rule;

calculating (207) the prediction information (206) so that the prediction residual signal (205) fulfills an optimization target (208);

encoding (209) the first combination signal (204) and the prediction residual signal (205) to obtain an encoded first combination signal (210) and an encoded residual signal (211); and

combining (212) the encoded first combination signal (210), the encoded prediction residual signal (211) and the prediction information (206) to obtain an encoded multi-channel audio signal,

wherein the first channel signal is a spectral representation of a block of samples;

wherein the second channel signal is a spectral representation of a block of samples,

wherein the spectral representations are either pure real spectral representations or pure imaginary spectral representations,

wherein the prediction information ~~(206)~~ is calculated as a real-valued factor different from zero and/or as an imaginary factor different from zero,

a real-to-imaginary transform ~~(2070)~~ or an imaginary-to-real transform is performed for deriving a transform spectral representation from the first combination signal, and

wherein the first combined signal ~~(204)~~ and the first residual signal ~~(2032)~~ are calculated so that the prediction signal is derived from the transformed spectrum using the imaginary factor.

21. Computer program for performing, when running on a computer or a processor, the method of claim 19 or the method of claim 20.