Claims

1. Audio encoder for encoding an audio signal, comprising:

a first encoding processor ~~(600)~~ for encoding a first audio signal portion in a frequency domain, wherein the first encoding processor ~~(600)~~ comprises:

a time frequency converter ~~(602)~~ for converting the first audio signal portion into a frequency domain representation having spectral lines up to a maximum frequency of the first audio signal portion;

an analyzer ~~(604)~~ for analyzing the frequency domain representation up to the maximum frequency to determine first spectral portions to be encoded with a first spectral resolution and second spectral portions to be encoded with a second spectral resolution, the second spectral resolution being lower than the first spectral resolution, wherein the analyzer ~~(604)~~ is configured to determine a first spectral portion ~~(306)~~ from the first spectral portions, the first spectral portion being placed, with respect to frequency, between two second spectral portions ~~(307a, 307b)~~ from the second spectral portions;

a spectral encoder ~~(606)~~ for encoding the first spectral portions with the first spectral resolution and for encoding the second spectral portions with the second spectral resolution, wherein the spectral encoder comprises a parametric coder for calculating spectral envelope information having the second spectral resolution from the second spectral portions;

a second encoding processor ~~(610)~~ for encoding a second different audio signal portion in the time domain, wherein the second encoding processor ~~(610)~~ comprises:

a sampling rate converter ~~(900)~~ for converting the second audio signal portion to a lower sampling rate representation, the lower sampling rate being lower than a sampling rate of the audio signal, wherein the lower sampling rate representation does not include the high band of the input signal;

a time domain low band encoder ~~(910)~~ for time domain encoding the lower sampling rate representation; and

a time domain bandwidth extension encoder ~~(920)~~ for parametrically encoding the high band;

a controller ~~(620)~~ configured for analyzing the audio signal and for determining, which portion of the audio signal is the first audio signal portion encoded in the frequency domain and which portion of the audio signal is the second audio signal portion encoded in the time domain; and

an encoded signal former ~~(630)~~ for forming an encoded audio signal comprising a first encoded signal portion for the first audio signal portion and a second encoded signal portion for the second audio signal portion.

2. Audio encoder of claim 1, further comprising:

a preprocessor ~~(1000)~~ configured for preprocessing the first audio signal portion and the second audio signal portion,

wherein the preprocessor comprises:

a prediction analyzer ~~(1002)~~ for determining prediction coefficients; and

wherein the second encoding processor comprises:

a prediction coefficient quantizer ~~(1010)~~ for generating a quantized version of the prediction coefficients; and

an entropy coder for generating an encoded version of the quantized prediction coefficients,

wherein the encoded signal former ~~(630)~~ is configured for introducing the encoded version into the encoded audio signal.

3. Audio encoder of claims 1 or 2,

wherein a preprocessor ~~(1000)~~ comprises a resampler ~~(1004)~~ for resampling the audio signal to a sampling rate of the second encoding processor; and

wherein a prediction analyzer is configured to determine the prediction coefficients using a resampled audio signal, or

wherein the preprocessor ~~(1000)~~ further comprises a long term prediction analysis stage ~~(1006)~~ for determining one or more long term prediction parameters for the first audio signal portion.

4. Audio encoder of one of the preceding claims, further comprising a cross-processor ~~(700)~~ for calculating, from the encoded spectral representation of the first audio signal portion, initialization data of the second encoding processor ~~(610)~~, so that the second encoding processing ~~(610)~~ is initialized to encode the second audio signal portion immediately following the first audio signal portion in time in the audio signal.

5. Audio encoder of claim 4, wherein the cross-processor ~~(700)~~ comprises:

a spectral decoder ~~(701)~~ for calculating a decoded version of the first encoded signal portion;

a delay stage ~~(707)~~ for feeding a delayed version of the decoded version into a de-emphasis stage ~~(617)~~ of the second encoding processor for initialization;

a weighted prediction coefficient analysis filtering block ~~(708)~~ for feeding a filter output into a codebook determinator ~~(613)~~ of the second encoding processor ~~(610)~~ for initialization;

an analysis filtering stage ~~(706)~~ for filtering the decoded version or a pre-emphasized ~~(709)~~ version and for feeding a filter residual into an adaptive codebook determinator ~~(612)~~ of the second encoding processor for initialization; or

a pre-emphasis filter (709) for filtering the decoded version and for feeding a delayed or pre-emphasized version to a synthesis filtering stage (616) of the second encoding processor (610) for initialization.

6. Audio encoder of one of the preceding claims,

wherein the analyzer (604) is configured to perform a temporal tile shaping or temporal noise shaping analysis or an operation of setting to zero spectral values in the second spectral portions,

wherein the first encoding processor (600) is configured to perform a shaping (606a) of spectral values of the first spectral portions using prediction coefficients (1010) derived from the first audio signal portion, and wherein the first encoding processor (600) is furthermore configured to perform a quantization and entropy coding operation (606b) of shaped spectral values of the first spectral portions, and

wherein spectral values of the second spectral portions are set to zero.

7. Audio encoder of claim 6, further comprising a cross-processor (700), wherein the cross-processor (700) comprises:

a noise shaper (703) for shaping quantized spectral values of the first spectral portions using LPC coefficients (1010) derived from the first audio signal portion;

a spectral decoder (704, 705) for decoding the spectrally shaped spectral portions of the first spectral portion with a high spectral resolution and for synthesizing second spectral portions using a parametric representation of the second spectral portions and at least a decoded first spectral portion to obtain a decoded spectral representation;

a frequency-time converter (702) for converting the spectral representation into a time domain to obtain a decoded first audio signal portion, wherein a sampling rate associated with the decoded first audio signal portion is different than a sampling rate of the audio signal, and a sampling rate associated with an output signal of the frequency-time converter (702) is different from a sampling rate of the audio signal input into the frequency-time converter (602).

8. Audio encoder of one of the preceding claims,

wherein the second encoding processor comprises at least one block of the following group of blocks:

a prediction analysis filter ~~(611)~~;

an adaptive codebook stage ~~(612)~~;

an innovative codebook stage ~~(614)~~;

an estimator ~~(613)~~ for estimating an innovative codebook entry;

an ACELP/gain coding stage ~~(615)~~;

a prediction synthesis filtering stage ~~(616)~~;

a de-emphasis stage ~~(617)~~; and

a bass post-filter analysis stage ~~(618)~~.

9. Audio encoder of one of the preceding claims,

wherein the time domain encoding processor has an associated second sampling rate,

wherein the frequency domain encoding processor has associated therewith a first sampling rate being higher than the second sampling rate, wherein the audio encoder further comprises a cross-processor ~~(700)~~ for calculating, from the encoded spectral representation of the first audio signal portion, initialization data of the second encoding processor,

wherein the cross-processor comprises a frequency-time converter ~~(702)~~ for generating a time domain signal at the second sampling rate,

wherein the frequency time converter ~~(702)~~ comprises:

a selector ~~(726)~~ for selecting a low portion of a spectrum input into the frequency time converter in accordance with a ratio of the first sampling rate and the second sampling rate, the ratio being smaller than 1,

a transform processor ~~(720)~~ having a transform length being smaller than a transform length of the time-frequency converter ~~(602)~~; and

a synthesis windower ~~(712)~~ for windowing using a window having a smaller number of window coefficients compared to a window used by the time frequency converter ~~(602)~~.

10. Audio decoder for decoding an encoded audio signal, comprising:

a first decoding processor ~~(1120)~~ for decoding a first encoded audio signal portion in a frequency domain, the first decoding processor ~~(1120)~~ comprising:

a spectral decoder ~~(1122)~~ for decoding first spectral portions with a high spectral resolution and for synthesizing second spectral portions using a parametric representation of the second spectral portions and at least a decoded first spectral portion to obtain a decoded spectral representation, wherein the spectral decoder ~~(1122)~~ is configured to generate the first decoded representation so that a first spectral portion ~~(306)~~ is placed with respect to frequency between two second spectral portions ~~(307a, 307b)~~; and

a frequency-time converter ~~(1120)~~ for converting the decoded spectral representation into a time domain to obtain a decoded first audio signal portion;

a second decoding processor ~~(1140)~~ for decoding a second encoded audio signal portion in the time domain to obtain a decoded second audio signal portion, wherein the second decoding processor comprises:

a time domain low band decoder ~~(1200)~~ for decoding a low band time domain signal;

an upsampler ~~(1210)~~ for upsampling the low band time domain signal;

a time domain bandwidth extension decoder ~~(1220)~~ for synthesizing a high band of a time domain output signal; and

a mixer ~~(1230)~~ for mixing a synthesized high band of the time domain signal and an upsampled low band time domain signal; and

a combiner ~~(1160)~~ for combining the decoded first spectral portion and the decoded second spectral portion to obtain a decoded audio signal.

11. Audio decoder of claim 10,

wherein the upsampler ~~(1210)~~ comprises an analysis filterbank ~~(1471)~~ operating at a first time domain low band decoder sampling rate and a synthesis filterbank ~~(1473)~~ operating at a second output sampling rate being higher than the first time domain low band sampling rate.

12. Audio decoder of claim 10 or 11,

wherein the time domain low band decoder ~~(1200)~~ comprises a residual signal, a decoder ~~(1149, 1141, 1142)~~ and a synthesis filter ~~(1143)~~ for filtering a residual signal using synthesis filter coefficients ~~(1145)~~,

wherein the time domain bandwidth extension decoder ~~(1220)~~ is configured to upsample the residual signal ~~(1221)~~ and to process ~~(1222)~~ an upsampled residual signal using a non-linear operation to obtain a high band residual signal, and to spectrally shape ~~(1223)~~ the high band residual signal to obtain the synthesized high band.

13. Audio decoder of one of the claims 10 to 12,

wherein the first decoding processor (1120) comprises an adaptive long term prediction post-filter (1420) for post-filtering the first decoded first signal portion, wherein the filter (1420) is controlled by one or more long term prediction parameters included in the encoded audio signal.

14. Audio decoder of one of claims 10 to 13, further comprising:

a cross-processor (1170) for calculating, from the decoded spectral representation of the first encoded audio signal portion, initialization data of the second decoding processor (1140), so that the second decoding processor (1140) is initialized to decode the encoded second audio signal portion following in time the first audio signal portion in the encoded audio signal.

15. Audio decoder of claim 14, wherein the cross-processor further comprises:

a frequency-time converter (1170) operating at a lower sampling rate than the frequency-time converter (1124) of the first decoding processor (1120) to obtain a further decoded first signal portion in the time domain,

wherein the signal output by the frequency-time converter (1171) has a second sampling rate being lower than the first sampling rate associated with an output of the frequency-time converter (1124) of the second decoding processor,

wherein the additional frequency-time converter (1171) comprises a selector (726) for selecting a low portion of a spectrum input into the additionally frequency-time converter (1171) in accordance with a ratio of the first sampling rate and the second sampling rate, the ratio being smaller than 1;

a transform processor (720) having a transform length being smaller than a transform length (710) of the time-frequency converter (1124); and

a synthesis windower (722) using a window having a smaller number of coefficients compared to a window used by the frequency-time converter (1124).

16. Audio decoder of one of claims 14 or 15,

wherein the cross-processor ~~(1170)~~ comprises:

a delay stage ~~(1172)~~ for delaying the further decoded first signal portion and for feeding a delayed version of the decoded first signal portion into a de-emphasis stage ~~(1144)~~ of the second decoding processor for initialization;

a pre-emphasis filter ~~(1173)~~ and a delay stage ~~(1175)~~ for filtering and delaying the further decoded first signal portion and for feeding a delay stage output into a prediction synthesis filter ~~(1143)~~ of the second decoding processor for initialization;

a prediction analysis filter ~~(1174)~~ for generating a prediction residual signal from the further decoded first spectral portion or a pre-emphasized ~~(1173)~~ further decoded first signal portion and for feeding a prediction residual signal into a codebook synthesizer ~~(1141)~~ of the second decoding processor ~~(1200)~~; or

a switch ~~(1480)~~ for feeding the further decoded first signal portion into an analysis stage ~~(1471)~~ of a resampler ~~(1210)~~ of the second decoding processor for initialization.

17. Audio decoder of one of claims 10 to 16,

wherein the second decoding processor ~~(1200)~~ comprises at least one block of the group of blocks comprising:

an ACELP for decoding gains and an innovative codebook;

an adaptive codebook synthesis stage ~~(1141)~~;

an ACELP post-processor ~~(1142)~~;

a prediction synthesis filter ~~(1143)~~; and

a de-emphasis stage ~~(1144)~~.

18. Method of encoding an audio signal, comprising:

first encoding ~~(600)~~ a first audio signal portion in a frequency domain, wherein the first encoding ~~(600)~~ comprises:

converting ~~(602)~~ the first audio signal portion into a frequency domain representation having spectral lines up to a maximum frequency of the first audio signal portion;

analyzing ~~(604)~~ the frequency domain representation up to the maximum frequency to determine first spectral portions to be encoded with a first spectral resolution and second spectral portions to be encoded with a second spectral resolution, the second spectral resolution being lower than the first spectral resolution, wherein the analyzing ~~(604)~~ determines a first spectral portion ~~(306)~~ from the first spectral portions, the first spectral portion being placed, with respect to frequency, between two second spectral portions ~~(307a, 307b)~~ from the second spectral portions;

encoding ~~(606)~~ the first spectral portions with the first spectral resolution and for encoding the second spectral portions with the second spectral resolution, wherein the encoding the second spectral portion comprises calculating, from the second spectral portions, spectral envelope information having the second spectral resolution;

second encoding ~~(610)~~ a second different audio signal portion in the time domain~~;~~ wherein the second encoding ~~(610)~~ comprises:

converting ~~(900)~~ the second audio signal portion to a lower sampling rate representation, the lower sampling rate being lower than a sampling rate of the audio signal, wherein the lower sampling rate representation does not include the high band of the input signal;

time domain encoding ~~(910)~~ the lower sampling rate representation; and

parametrically encoding ~~(920)~~ the high band;

analyzing ~~(620)~~ the audio signal and determining, which portion of the audio signal is the first audio signal portion encoded in the frequency domain and which portion

of the audio signal is the second audio signal portion encoded in the time domain; and

forming ~~(630)~~ an encoded audio signal comprising a first encoded signal portion for the first audio signal portion and a second encoded signal portion for the second audio signal portion.

19. Method of decoding an encoded audio signal, comprising:

first decoding ~~(1120)~~ a first encoded audio signal portion in a frequency domain, the first decoding ~~(1120)~~ comprising:

decoding ~~(1122)~~ first spectral portions with a high spectral resolution and synthesizing second spectral portions using a parametric representation of the second spectral portions and at least a decoded first spectral portion to obtain a decoded spectral representation, wherein decoding ~~(1122)~~ comprises generating the first decoded representation so that a first spectral portion ~~(306)~~ is placed with respect to frequency between two second spectral portions ~~(307a, 307b)~~; and

converting ~~(1120)~~ the decoded spectral representation into a time domain to obtain a decoded first audio signal portion;

second decoding ~~(1140)~~ a second encoded audio signal portion in the time domain to obtain a decoded second audio signal portion, wherein the second decoding comprises:

decoding ~~(1200)~~ a low band time domain signal;

upsampling ~~(1210)~~ the low band time domain signal;

synthesizing ~~(1220)~~ a high band of a time domain output signal; and

mixing ~~(1230)~~ a synthesized high band of the time domain signal and an upsampled low band time domain signal; and

combining ~~(1160)~~ the decoded first spectral portion and the decoded second spectral portion to obtain a decoded audio signal.

20. Computer program for performing, when running on a computer or a processor, the method of claim 18 or claim 19.