Claims

1. Encoder (100; 200; 300) for encoding an audio signal (102), the encoder comprising

an analyzer (120; 320) configured for deriving prediction coefficients (122; 322) and a residual signal (124; 324) from a frame of the audio signal (102);

a formant information calculator (160) configured for calculating a speech related spectral shaping information (162) from the prediction coefficients (122; 322);

a gain parameter calculator (150; 350; 350'; 550) configured for calculating a gain parameter (g_n; g_c) from an unvoiced residual signal and the spectral shaping information (162); and

a bitstream former (190; 690) configured for forming an output signal (192; 692) based on an information (142) related to a voiced signal frame, the gain parameter (g_n; g_c) or a quantized gain parameter ($\hat{g}_c$; $\hat{g}_n$) and the prediction coefficients (122; 322);

wherein the gain parameter calculator (150; 350; 350'; 550) comprises a noise generator (350a) configured for generating an encoding noise-like signal (n(n)); and

wherein the gain parameter calculator (150; 350; 350'; 550) comprises a shaping processor (350d) configured for shaping the spectrum of the noise-like signal (n(n)) using the speech related spectral shaping information (162) and a variable amplifier (350e) configured for amplifying the spectrum of the shaped noise-like signal (350f) to obtain an amplified shaped noise-like signal (350g) and a controller (350k; 550n) for calculating a gain parameter (g_n; g_c) based on the amplified shaped noise-like signal (350g).

2. Encoder according to claim 1, wherein the gain parameter calculator (150; 350; 350'; 550) comprises a comparer (350h; 350'; 550l) configured for comparing the unvoiced residual signal and the amplified shaped noise-like signal (350g) to obtain a comparison result (350), wherein the controller (350k; 550n) is configured for determining the gain parameter (g_n(temp)) based on the comparison result (350i).

3. Encoder according to claim 1 or 2, further comprising a decider (130) configured for determining if the residual signal was determined from an unvoiced signal audio frame;

4. Encoder according to one of claims 1-3, wherein the gain parameter calculator (150; 350; 350'; 550) comprises:

a noise generator (350a) configured for generating an encoding noise-like signal (n(n));

a shaper (350c) configured for amplifying (350e) and shaping (350d) a spectrum of the encoding noise-like signal (n(n)) using the speech related spectral shaping information (162) and the gain parameter (g_n) as temporary gain parameter (g_n(temp)) to obtain an amplified shaped encoding noise-like signal (350g);

a comparer (350h) configured for comparing the unvoiced residual signal and the amplified shaped encoding noise-like signal (350g) to obtain a measure for a likeness between the unvoiced residual signal and the amplified shaped encoding noise-like signal (350g); and

a controller (350k) configured for determining the gain parameter (g_n) and to adapt the temporary gain parameter (g_n(temp)) based on the comparison result;

wherein the controller (350k; 550n) is configured to provide the encoding gain parameter (g_n) to the bitstream former, when a value of the measure for the likeness is above a threshold value.

5. Encoder according to one of claims 1-3, wherein the gain parameter calculator (150; 350; 350'; 550) comprises:

a noise generator (350a) configured for generating an encoding noise-like signal;

a shaper (350c) configured for amplifying (350e) and shaping (350d) a spectrum of the encoding noise-like signal (n(n)) using the speech related spectral shaping information (162) and the gain parameter (g_n) as temporary gain parameter (g_n(temp)) to obtain an amplified shaped encoding noise-like signal (350g);

a synthesizer (350m') configured for synthesizing a synthesized signal (350l') from the amplified shaped encoding noise-like signal (350g) and the prediction coefficients (122; 322) and to provide the synthesized signal (350l');

a comparer (350h') configured for comparing the audio signal (102) and the synthesized signal (350l') to obtain a measure for a likeness between the audio signal (102) and the synthesized signal (350l'); and

a controller (350k) configured for determining the gain parameter (g_n) and to adapt the temporary gain parameter ($g_n(temp)$) based on the comparison result;

wherein the controller (350k) is configured to provide the encoding gain parameter (g_n) to the bitstream former, when a value of the measure for the likeness is above a threshold value.

6. Encoder according to claim 5, further comprising a gain memory (350n') configured for recording an encoding information comprising the encoding gain parameter (g_n; g_c) or an information $\hat{g}_n$ related thereto, wherein the controller (350k) is configured to record the encoding information during processing of the audio frame and for determining the gain parameter (g_n; g_c) for a subsequent frame of the audio signal (102) based on the encoding information of the preceding frame of the audio signal (102).

7. Encoder according to one of claims claim 4-6, wherein the noise generator (350a) is configured for generating a plurality of random signals and to combine the plurality of random signals to obtain the encoding noise-like signal (n(n)).

8. Encoder according to one of previous claims, further comprising a quantizer (170) configured for receiving the gain parameter (g_n; g_c), for quantizing the gain parameter (g_n; g_c) to obtain the quantized gain parameter ($\hat{g}_c$; $\hat{g}_n$).

9. Encoder according to one of previous claims, wherein the gain parameter calculator (350; 350') is configured for combining a spectrum of the encoding noise-like signal (n(n)) or a spectrum derived thereof and a transfer function (Ffe(z)) comprising

$$Ffe(z) = \frac{A(z/w1)}{A(z/w2)}$$

wherein A(z) corresponds to a filter polynomial of the encoding filter for filtering the adapted shaped encoding noise-like signal weighted by weighting factors w1 or w2, wherein w1 comprises a positive non zero scalar value of at most 1.0 and wherein w2 comprises a positive non zero scalar value of at most 1.00, wherein w2 is greater than w1.

10. Encoder according to one of previous claims, wherein the gain parameter calculator (350; 350') is configured for combining a spectrum of the encoding noise-like signal or a spectrum derived thereof with a transfer function (Ft(z)) comprising

$$Ft(z) = 1 - \beta z^{-1}$$

wherein z indicates a representation in the z-domain, wherein β represents a measure (voicing) for a voicing determined by relating an energy of a past frame of the audio signal and an energy of a present frame of the audio signal, wherein the measure β is determined in function of a voicing value.:

11. Decoder (200) for decoding a received signal (202) comprising information related to prediction coefficients (122; 322), the decoder (200) comprising

a formant information calculator (220; 1090) configured for calculating a speech related spectral shaping information (222; 1092, 1092a, 1092b) from the prediction coefficients;

a noise generator (240; 1020) configured for generating a decoding noise-like signal (n(n); 1022);

a shaper (250; 1080) configured for shaping (252) a spectrum of the decoding noise-like signal (n(n); 1022) using the speech related spectral shaping information (222; 1092, 1092b) and for amplifying (254) the spectrum of the shaped decoding noise-like signal (256) to obtain an amplified shaped decoding noise-like signal (258; 1022'); and

a synthesizer (260; 1060) configured for synthesizing a synthesized signal (262) from the amplified shaped decoding noise-like signal (258; 1022') and the prediction coefficients (122; 322).

12. Decoder according to claim 11, comprising a signal generator (1010) configured to generate a code excited excitation signal (1012) using the prediction coefficients and comprising a further shaper (1070) configured for shaping the code excited excitation signal using the speech related shaping information (1092, 1092b) and for amplifying (254) the spectrum of the shaped code excited excitation signal to obtain an amplified shaped code excited excitation signal (258; 1022').

13. Decoder according to claim 12, wherein the formant information calculator (1090) is configured to provide different speech related shaping information (1092a; 1092b) to the shaper (1080) and to the further shaper (1070).

14. Decoder according to one of claims 11-13, wherein the received signal (202) comprises an information related to a gain parameter (g_n; g_c) and wherein the shaper (250) comprises an amplifier (254) configured for amplifying the decoding noise-like signal (n(n)) or the shaped decoding noise-like signal (256).

15. Decoder according to one of claims 11-14, wherein the received signal (202) further comprises a voiced information (142) related to a voiced frame of an encoded audio signal (102) and wherein the decoder (200) further comprises a voiced frame processor (270) configured for determining a voiced signal (272) based on the voiced information (142), wherein the decoder (200) further comprises a combiner (280) configured for combining the synthesized signal (262) and the voiced signal (272) to obtain a frame of an audio signal sequence (282).

16. Method (1200) for encoding an audio signal (102), comprising

deriving (1210) prediction coefficients (122; 322) and a residual signal from an audio signal frame (102);

calculating (1220) a speech related spectral shaping information (162) from the prediction coefficients (122; 322);

calculating (1230) a gain parameter (g_n; g_c) from an unvoiced residual signal and the spectral shaping information (162); and

forming (1240) an output signal (192; 692) based on an information (142) related to a voiced signal frame, the gain parameter (g_n; g_c) or a quantized gain parameter ($\hat{g}_c$; $\hat{g}_n$) and the prediction coefficients (122; 322); and

generating an encoding noise-like signal (n(n)), comprising:

shaping the spectrum of the noise-like signal (n(n)) using the speech related spectral shaping information (162); and

amplifying the spectrum of the shaped noise-like signal (350f) to obtain an amplified shaped noise-like signal (350g);

calculating a gain parameter (g_n; g_c) based on the amplified shaped noise-like signal (350g).

17. Method (1300) for decoding a received audio signal (202) comprising an information related prediction coefficients and a gain parameter (g_n; g_c), the method comprising

calculating (1310) a speech related spectral shaping information (222) from the prediction coefficients (122; 322);

generating (1320) a decoding noise-like signal (n(n));

shaping (1330) a spectrum of the decoding noise-like signal (n(n)) using the speech related spectral shaping information (222; 1092, 1092b);

amplifying (254) the spectrum of the shaped noise-like signal (256) to obtain an amplified shaped decoding noise-like signal (258; 1022'); and

synthesizing (1340) a synthesized signal (262) from the amplified shaped encoding noise-like signal (258) and the prediction coefficients (122; 322).

18. Computer program having a program code for performing, when running on a computer, a method according to claim 16 or 17.

Claims

1. Encoder for encoding an audio signal, the encoder comprising

an analyzer configured for deriving prediction coefficients and a residual signal from a frame of the audio signal;

a formant information calculator configured for calculating a speech related spectral shaping information from the prediction coefficients;

a gain parameter calculator configured for calculating a gain parameter from an unvoiced residual signal and the spectral shaping information; and

a bitstream former configured for forming an output signal based on an information related to a voiced signal frame, the gain parameter or a quantized gain parameter and the prediction coefficients.

2. Encoder according to claim 1, further comprising a decider configured for determining if the residual signal was determined from an unvoiced signal audio frame;

3. Encoder according to claim 1 or claim 2, wherein the gain parameter calculator comprises:

a noise generator configured for generating an encoding noise-like signal;

a shaper configured for amplifying and shaping a spectrum of the encoding noise-like signal using the speech related spectral shaping information and the gain parameter as temporary gain parameter to obtain an amplified shaped encoding noise-like signal;

a comparer configured for comparing the unvoiced residual signal and the amplified shaped encoding noise-like signal to obtain a measure for a likeness between the unvoiced residual signal and the amplified shaped encoding noise-like signal; and

a controller configured for determining the gain parameter and to adapt the temporary gain parameter based on the comparison result;

wherein the controller is configured to provide the encoding gain parameter to the bitstream former, when a value of the measure for the likeness is above a threshold value.

4. Encoder according to claim 1 or 2, wherein the gain parameter calculator comprises:

a noise generator configured for generating an encoding noise-like signal;

a shaper configured for amplifying and shaping a spectrum of the encoding noise-like signal using the speech related spectral shaping information and the gain parameter as temporary gain parameter to obtain an amplified shaped encoding noise-like signal;

a synthesizer configured for synthesizing a synthesized signal from the amplified shaped encoding noise-like signal and the prediction coefficients and to provide the synthesized signal;

a comparer configured for comparing the audio signal and the synthesized signal to obtain a measure for a likeness between the audio signal and the synthesized signal; and

a controller configured for determining the gain parameter and to adapt the temporary gain parameter based on the comparison result;

wherein the controller is configured to provide the encoding gain parameter to the bitstream former, when a value of the measure for the likeness is above a threshold value.

5. Encoder according to claim 4, further comprising a gain memory configured for recording an encoding information comprising the encoding gain parameter or an information related thereto, wherein the controller is configured to record the encoding information during processing of the audio frame and for determining the gain parameter for a subsequent frame of the audio signal based on the encoding information of the preceding frame of the audio signal.

6. Encoder according to one of claims claim 3-5, wherein the noise generator is configured for generating a plurality of random signals and to combine the plurality of random signals to obtain the encoding noise-like signal.

7. Encoder according to one of previous claims, further comprising a quantizer configured for receiving the gain parameter, for quantizing the gain parameter to obtain the quantized gain parameter.

8. Encoder according to one of previous claims, wherein the shaper is configured for combining a spectrum of the encoding noise-like signal or a spectrum derived thereof and a transfer function (Ffe(z)) comprising

$$Ffe(z) = \frac{A(z/w1)}{A(z\,/w2)}$$

wherein A(z) corresponds to a filter polynomial of the encoding filter for filtering the adapted shaped encoding noise-like signal weighted by weighting factors w1 or w2, wherein w1 comprises a positive non zero scalar value of at most 1.0 and wherein w2 comprises a positive non zero scalar value of at most 1.00, wherein w2 is greater than w1.

9. Encoder according to one of previous claims, wherein the shaper is configured for combining a spectrum of the encoding noise-like signal or a spectrum derived thereof with a transfer function (Ft(z)) comprising

$$Ft(z) = 1 - \beta z^{-1}$$

wherein z indicates a representation in the z-domain, wherein β represents a measure (voicing) for a voicing determined by relating an energy of a past frame of the audio signal and an energy of a present frame of the audio signal, wherein the measure β is determined in function of a voicing value.:

10. Decoder for decoding a received signal comprising information related to prediction coefficients, the decoder comprising

a formant information calculator configured for calculating a speech related spectral shaping information from the prediction coefficients;

a noise generator configured for generating a decoding noise-like signal;

a shaper configured for shaping a spectrum of the decoding noise-like signal or an amplified representation thereof using the spectral shaping information to obtain a shaped decoding noise-like signal; and

a synthesizer configured for synthesizing a synthesized signal from the amplified shaped encoding noise-like signal and the prediction coefficients.

11. Decoder according to claim 10, wherein the received signal comprises an information related to a gain parameter and wherein the shaper comprises an amplifier configured for amplifying the decoding noise-like signal or the shaped decoding noise-like signal.

12. Decoder according to claim 10 or 11, wherein the received signal further comprises a voiced information related to a voiced frame of an encoded audio signal and wherein the decoder further comprises a voiced frame processor configured for determining a voiced signal based on the voiced information, wherein the decoder further comprises a combiner configured for combining the synthesized signal and the voiced signal to obtain a frame of an audio signal sequence.

13. Encoded audio signal comprising prediction coefficient information for a voiced frame and an unvoiced frame, a further information related to the voiced signal frame and an information related to a gain parameter or a quantized gain parameter for the unvoiced frame.

14. Method for encoding an audio signal, comprising

deriving prediction coefficients and a residual signal from an audio signal frame;

calculating a speech related spectral shaping information from the prediction coefficients;

calculating a gain parameter from an unvoiced residual signal and the spectral shaping information; and

forming an output signal based on an information related to a voiced signal frame, the gain parameter or a quantized gain parameter and the prediction coefficients.

15. Method for decoding a received audio signal comprising an information related prediction coefficients and a gain parameter, the method comprising

calculating a speech related spectral shaping information from the prediction coefficients;

generating a decoding noise-like signal;

shaping a spectrum of the decoding noise-like signal or an amplified representation thereof using the spectral shaping information to obtain a shaped decoding noise-like signal; and

synthesizing a synthesized signal from the amplified shaped encoding noise-like signal and the prediction coefficients.

16. Computer program having a program code for performing, when running on a computer, a method according to claim 14 or 15.