Claims

1. Audio encoder for encoding an audio signal (AS) so as to produce therefrom an encoded signal (ES), the audio encoder (1) comprising:

a framing device (2) configured to extract frames (F) from the audio signal (AS);

a quantizer (3) configured to map spectral lines (SL_{1-32}) of a spectrum signal (SPS) derived from the frame (F) of the audio signal (AS) to quantization indices (I_0, I_1), wherein the quantizer (3) has a dead-zone (DZ), in which the spectral lines (SL_{1-32}) are mapped to quantization index zero (I_0); and

a control device (4) configured to modify the dead-zone (DZ);

wherein the control device (4) comprises a tonality calculating device (5) configured to calculate at least one tonality indicating value (TI_{5-32}) for at least one spectrum line (SL_{1-32}) or for at least one group of spectral lines (SL_{1-32}),

wherein the control device (4) is configured to modify the dead-zone (DZ) for the at least one spectrum line (SL_{1-32}) or the at least one group of spectrum lines (SL_{1-32}) depending on the respective tonality indicating value (TI_{5-32}).

2. Audio encoder according to the preceding claim, wherein the control device (4) is configured to modify the dead-zone (DZ) in such way that the dead-zone (DZ) at one of the spectral lines (SL_{1-32}) is larger than the dead-zone (DZ) is at one of the spectral lines (SL_{1-32}) having a larger tonality or in such way that the dead-zone (DZ) at one of the groups of

spectral lines (SL_{1-32}) is larger than the dead-zone (DZ) is at one of the groups of spectral lines (SL_{1-32}) having a larger tonality.

3. Audio encoder according to one of the preceding claims, wherein the control device (4) comprises a power spectrum calculating device (6) configured to calculate a power spectrum (PS) of the frame (F) of the audio signal (AS), wherein the power spectrum (PS) comprises power values (PS_{5-32}) for spectral lines (SL_{1-32}) or groups of spectral lines (SL_{1-32}), wherein the tonality calculating device (4) is configured to calculate the at least one tonality indicating value (T_{5-32}) depending on the power spectrum (PS).

4. Audio encoder according to the preceding claim, wherein the tonality indicating value (TI_{5-32}) for one of the spectral lines (SL_{1-32}) is based on a comparison of the power value (PS_{5-32}) for the respective spectral line (SL_{1-32}) and the sum of a predefined number of its surrounding power values (P_{5-32}) of the power spectrum (PS), or wherein the tonality indicating value (TI_{5-32}) for one of the groups of the spectral lines (SL_{1-32}) is based on a comparison of the power value (PS_{5-32}) for the respective group of spectral lines (SL_{1-32}) and the sum of a predefined number of its surrounding power values (PS_{5-32}) of the power spectrum (PS).

5. Audio encoder according to one of the preceding claims, wherein the tonality indicating value (TI_{5-32}) for one of the spectral lines (SL_{1-32}) is based on the tonality indicating value (TI_{5-32}) of the spectral line of a preceding frame (F) of the audio signal (AS), or wherein the tonality indicating value (TI_{5-32}) for one of the groups of the spectral lines (SL_{1-32}) is based on the tonality indicating value (TI_{5-32}) of the group of spectral lines (SL_{1-32}) for a preceding frame (F) of the audio signal (AS).

6. Audio encoder according to one of the claims 3 to 5, wherein the tonality indicating value (TI_{5-32}) is calculated by a formula

$$T_{k,i} = f\left(\frac{P_{k-7,i}+\cdots+P_{k-1,i}+P_{k+1,i}+\cdots+P_{k+7,i}}{P_{k,i}}, \frac{P_{k-7,i-1}+\cdots+P_{k-1,i-1}+P_{k+1,i-1}+\cdots+P_{k+7,i-1}}{P_{k,i-1}}\right),$$

wherein *i* is an index indicating a specific frame (F) of the audio signal (AS), *k* is an index indicating a specific spectral line, $T_{k,i}$ is the tonality indicating value ($TI_{5\text{-}32}$) of the *k-th* spectral line of the *i-th* frame (F), $P_{k,i}$ is the power value ($PS_{5\text{-}32}$) of the *k-th* spectral line of the *i-th* frame (F), or wherein the tonality indicating value ($TI_{5\text{-}32}$) is calculated by a formula

$$T_{m,i} = f\left(\frac{P_{m-7,i}+\cdots+P_{m-1,i}+P_{m+1,i}+\cdots+P_{m+7,i}}{P_{m,i}}, \frac{P_{m-7,i-1}+\cdots+P_{m-1,i-1}+P_{m+1,i-1}+\cdots+P_{m+7,i-1}}{P_{m,i-1}}\right),$$

wherein *i* is an index indicating a specific frame (F) of the audio signal (AS), *m* is an index indicating a specific group of spectral lines ($SL_{1\text{-}32}$), $P_{m,i}$ is the power value of the *m-th* group of spectral lines ($SL_{1\text{-}32}$) of the *i-th* frame.

7. Audio encoder according to one of the preceding claims, wherein the audio encoder (1) comprises a start frequency calculating device (7) configured to calculate a start frequency (SF) for modifying the dead-zone (DZ), wherein the dead-zone (DZ) is only modified for spectral lines (SL) representing a frequency higher than or equal to the start frequency (SF).

8. Audio encoder according to the preceding claim, wherein start frequency calculating device (7) is configured to calculate the start frequency (SF) based on a sample rate of the audio signal (AS) and/or based on a maximum bit-rate foreseen for a bitstream produced from the encoded signal (ES).

9. Audio encoder according to one of the claims 3 to 8, wherein the audio encoder (1) comprises a modified discrete cosine transform calculating device (8) configured to calculate a modified discrete cosine transform (CT) from the frame (F) of the audio signal (AS) and a modified discrete sine transform calculating device (9) configured to calculate a modified discrete sine transform (ST) from the frame (F) of the audio signal (AS),

wherein the power spectrum calculating device (6) is configured to calculate the power spectrum (PS) based on the modified discrete cosine transform (CT) and on the modified discrete sine (ST) transform.

10. Audio encoder according to one of the claims 3 to 9, wherein power spectrum calculating device (6) is configured to calculate the power values ($PS_{5\text{-}32}$) according to a formula $P_{k,i} = (MDCT_{k,i})^2 + (MDST_{k,i})^2$, wherein *i* is an index indicating a specific frame of the audio signal, *k* is an index indicating a specific spectral line, $MDCT_{k,i}$ is the value of the modified discrete cosine transform (CT) at the *k-th* spectral line of the *i-th* frame, $MDST_{k,i}$ is the value of the modified discrete sine transform (ST) at the *k-th* spectral line of the *i-th* frame, and $P_{k,i}$ is the power value ($PS_{5\text{-}32}$) of the *k-th* spectral line of the *i-th* frame.

11. Audio encoder according to one of the preceding claims, wherein the audio encoder (1) comprises a spectrum signal calculating device (10) configured to produce the spectrum signal (SPS), wherein the spectrum signal calculating device (10) comprises an amplitude setting device (11) configured to set amplitudes of the spectral lines ($SL_{1\text{-}32}$) of the spectrum signal (SPS) in such way that an energy loss due to a modification of the dead-zone (DZ) is compensated.

12. Audio encoder according to the preceding claim, wherein the amplitude setting device (11) is configured to set the amplitudes of the spectrum signal (SPS) depending on a modification of the dead-zone (DZ) at the respective spectral line.

13. Audio encoder according to claim 11 or 12, wherein the spectrum signal calculating device (10) comprises a normalizing device (12).

14. Audio encoder according to one of the claims 11 to 13, wherein the modified discrete cosine transform (CT) from the frame (F) of the audio signal

(AS) calculated by the modified discrete cosine transform calculating device (8) is fed to the spectrum signal calculating device (10).

15. A system comprising an encoder (1) and a decoder, wherein the encoder (1) is designed according to one of the claims 1 to 14.

16. Method for encoding an audio signal (AS) so as to produce therefrom an encoded signal (ES), the method comprising the steps:

extracting frames (F) from the audio signal (AS);

mapping spectral lines (SL_{1-32}) of a spectrum signal (SPS) derived from the frame (F) of the audio signal (AS) to quantization indices (I_0, I_1), wherein a dead-zone (DZ) is used, in which the input spectral lines (SL_{1-32}) are mapped to quantization index zero (I_0); and

modifying the dead-zone (DZ);

wherein at least one tonality indicating value (TI_{5-32}) for at least one spectrum line or for at least one group of spectral lines (SL_{1-32}) is calculated,

wherein the dead-zone (DZ) for the at least one spectrum line or the at least one group of spectrum lines (SL_{1-32}) is modified depending on the respective tonality indicating value (TI_{5-32}).

17. Computer program for performing, when running on a computer or a processor, the method of claim 16.

Claims

1. Audio encoder for encoding an audio signal so as to produce therefrom an encoded signal, the audio encoder comprising:

a framing device configured to extract frames from the audio signal;

a quantizer configured to map spectral lines of a spectrum signal derived from the frame of the audio signal to quantization indices, wherein the quantizer has a dead-zone, in which the spectral lines are mapped to quantization index zero; and

a control device configured to modify the dead-zone;

wherein the control device comprises a tonality calculating device configured to calculate at least one tonality indicating value for at least one spectrum line or for at least one group of spectral lines,

wherein the control device is configured to modify the dead-zone for the at least one spectrum line or the at least one group of spectrum lines depending on the respective tonality indicating value.

2. Audio encoder according to the preceding claim, wherein the control device is configured to modify the dead-zone in such way that the dead-zone at one of the spectral lines is larger than the dead-zone is at one of the spectral lines having a larger tonality or in such way that the dead-zone at one of the groups of spectral lines is larger than the dead-zone is at one of the groups of spectral lines having a larger tonality.

3. Audio encoder according to one of the preceding claims, wherein the control device comprises a power spectrum calculating device configured to calculate a power spectrum of the frame of the audio signal, wherein the power spectrum comprises power values for spectral lines or groups of

spectral lines, wherein the tonality calculating device is configured to calculate the at least one tonality indicating value depending on the power spectrum.

4. Audio encoder according to the preceding claim, wherein the tonality indicating value for one of the spectral lines is based on a comparison of the power value for the respective spectral line and the sum of a predefined number of its surrounding power values of the power spectrum, or wherein the tonality indicating value for one of the groups of the spectral lines is based on a comparison of the power value for the respective group of spectral lines and the sum of a predefined number of its surrounding power values of the power spectrum.

5. Audio encoder according to one of the preceding claims, wherein the tonality indicating value for one of the spectral lines is based on the tonality indicating value of the spectral line of a preceding frame of the audio signal, or wherein the tonality indicating value for one of the groups of the spectral lines is based on the tonality indicating value of the group of spectral lines for a preceding frame of the audio signal.

6. Audio encoder according to one of the claims 3 to 5, wherein the tonality indicating value is calculated by a formula

$$T_{k,i} = f\left(\frac{P_{k-7,i}+\cdots+P_{k-1,i}+P_{k+1,i}+\cdots+P_{k+7,i}}{P_{k,i}}, \frac{P_{k-7,i-1}+\cdots+P_{k-1,i-1}+P_{k+1,i-1}+\cdots+P_{k+7,i-1}}{P_{k,i-1}}\right),$$

wherein *i* is an index indicating a specific frame of the audio signal, *k* is an index indicating a specific spectral line, $T_{k,i}$ is the tonality indicating value of the *k-th* spectral line of the *i-th* frame, $P_{k,i}$ is the power value of the *k-th* spectral line of the *i-th* frame, or wherein the tonality indicating value is calculated by a formula

$$T_{m,i} = f\left(\frac{P_{m-7,i}+\cdots+P_{m-1,i}+P_{m+1,i}+\cdots+P_{m+7,i}}{P_{m,i}}, \frac{P_{m-7,i-1}+\cdots+P_{m-1,i-1}+P_{m+1,i-1}+\cdots+P_{m+7,i-1}}{P_{m,i-1}}\right),$$

wherein *i* is an index indicating a specific frame of the audio signal, *m* is

an index indicating a specific group of spectral lines, $P_{m,i}$ is the power value of the *m-th* group of spectral lines of the *i-th* frame.

7. Audio encoder according to one of the preceding claims, wherein the audio encoder comprises a start frequency calculating device configured to calculate a start frequency for modifying the dead-zone, wherein the dead-zone is only modified for spectral lines representing a frequency higher than or equal to the start frequency.

8. Audio encoder according to the preceding claim, wherein start frequency calculating device is configured to calculate the start frequency based on a sample rate of the audio signal and/or based on a maximum bit-rate foreseen for a bitstream produced from the encoded signal.

9. Audio encoder according to one of the claims 3 to 8, wherein the audio encoder comprises a modified discrete cosine transform calculating device configured to calculate a modified discrete cosine transform from the frame of the audio signal and a modified discrete sine transform calculating device configured to calculate a modified discrete sine transform from the frame of the audio signal, wherein the power spectrum calculating device is configured to calculate the power spectrum based on the modified discrete cosine transform and on the modified discrete sine transform.

10. Audio encoder according to one of the claims 3 to 9, wherein power spectrum calculating device is configured to calculate the power values according to a formula $P_{k,i} = (MDCT_{k,i})^2 + (MDST_{k,i})^2$, wherein *i* is an index indicating a specific frame of the audio signal, *k* is an index indicating a specific spectral line, $MDCT_{k,i}$ is the value of the modified discrete cosine transform at the *k-th* spectral line of the *i-th* frame, $MDST_{k,i}$ is the value of the modified discrete sine transform at the *k-th* spectral line of the *i-th* frame, and $P_{k,i}$ is the power value of the *k-th* spectral line of the *i-th* frame.

11. Audio encoder according to one of the preceding claims, wherein the audio encoder comprises a spectrum signal calculating device configured to produce the spectrum signal, wherein the spectrum signal calculating device comprises an amplitude setting device configured to set amplitudes of the spectral lines of the spectrum signal in such way that an energy loss due to a modification of the dead-zone is compensated.

12. Audio encoder according to the preceding claim, wherein the amplitude setting device is configured to set the amplitudes of the spectrum signal depending on a modification of the dead-zone at the respective spectral line.

13. Audio encoder according to claim 11 or 12, wherein the spectrum signal calculating device comprises a normalizing device.

14. Audio encoder according to one of the claims 11 to 13, wherein the modified discrete cosine transform from the frame of the audio signal calculated by the modified discrete cosine transform calculating device is fed to the spectrum signal calculating device

15. A system comprising an encoder and a decoder, wherein the encoder is designed according to one of the claims 1 to 14.

16. Method for encoding an audio signal so as to produce therefrom an encoded signal, the method comprising the steps:

extracting frames from the audio signal;

mapping spectral lines of a spectrum signal derived from the frame of the audio signal to quantization indices, wherein a dead-zone is used, in which the input spectral lines are mapped to quantization index zero; and

modifying the dead-zone;

wherein at least one tonality indicating value for at least one spectrum line or for at least one group of spectral lines is calculated,

wherein the dead-zone for the at least one spectrum line or the at least one group of spectrum lines is modified depending on the respective tonality indicating value.

17. Computer program for performing, when running on a computer or a processor, the method of claim 16.