Claims

1. Comparison device for a multi-channel audio signal configured to:

derive, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensate the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

compute, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter including at least one side gain of at least one pair of mid/side transforms of the at least one pair of ITD compensated frequency transforms, the at least one side gain being a prediction gain of a side transform from a mid transform of the at least one pair of mid/side transforms, and at least one corrected residual gain corresponding to at least one residual gain corrected by a residual gain correction parameter, the at least one residual gain being a function of an energy of a residual in a prediction of the side transform from the mid transform relative to an energy of the mid transform,

wherein the comparison device is configured to compute the at least one side gain and the at least one residual gain using the energies and the inner product of the at least one pair of ITD compensated frequency transforms.

2. The comparison device according to claim 1, further configured to use frequency transforms of the audio signals of the at least one pair of channels in the analysis window for deriving the at least one ITD parameter.

3. The comparison device according to claim 1 or 2, further configured to:

compute the at least one comparison parameter using a function equaling or approximating an autocorrelation function of the analysis window and the at least one ITD parameter.

4. The comparison device according to claim 3, wherein

the function equals or approximates a normalized version of the autocorrelation function of the analysis window.

5. Comparison device for a multi-channel audio signal configured to:

derive, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensate the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

compute, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter,

wherein the comparison device is configured to compute the at least one comparison parameter using a function equaling or approximating an autocorrelation function of the analysis window and the at least one ITD parameter, and

wherein the function equals or approximates a normalized version of the autocorrelation function of the analysis window, and

wherein the comparison device is further configured to obtain the function by interpolation of the normalized version of the autocorrelation function of the analysis window stored in a look-up table.

6. Comparison device for a multi-channel audio signal configured to:

derive, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensate the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

compute, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter including at least one side gain of at least one pair of mid/side transforms of the at least one pair of ITD compensated frequency transforms, the at least one side gain being a prediction gain of a side transform from a mid transform of the at least one pair of mid/side transforms, and at least one corrected residual gain corresponding to at least one residual gain corrected by a residual gain correction parameter, the at least one residual gain being a function of an energy of a residual in a prediction of the side transform from the mid transform relative to an energy of the mid transform,

wherein the comparison device is further configured to:

correct the at least one residual gain by an offset corresponding to the residual gain correction parameter $\hat{r}_t$ computed as $\hat{r}_t = \frac{2c}{c+1}\sqrt{2\frac{1-\widehat{W}_X(ITD_t)}{1+c^2+2c\widehat{W}_X(ITD_t)}}$, wherein c is a scaling gain between the audio signals of the at least one pair of channels and $\widehat{W}_X(n)$ is a function approximating a normalized version of the autocorrelation function of the analysis window.

7. Comparison device for a multi-channel audio signal configured to:

derive, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensate the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

compute, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter, wherein

the at least one comparison parameter comprises at least one inter-channel coherence correction parameter for correcting an estimate of the ICC determined in the frequency domain of the at least one pair of audio signals based on the at least one ITD parameter.

8. The comparison device according to any one of claims 1 to 7, further configured to:

generate at least one downmix signal for the audio signals of the at least one pair of channels, wherein the at least one comparison parameter is computed for restoring the audio signals of the at least one pair of channels from the at least one downmix signal.

9. The comparison device according to any one of claims 1 to 8, further configured to:

generate the at least one downmix signal based on the at least one pair of ITD compensated frequency transforms.

10. Multi-channel encoder comprising the comparison device according to claim 8 or 9, further configured to:

encode the at least one downmix signal, the at least one ITD parameter and the at least one comparison parameter for transmission to a decoder.

11. Comparison method for a multi-channel audio signal comprising:

deriving, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensating the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

computing, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter including at least one side gain of at least one pair of mid/side transforms of the at least one pair

of ITD compensated frequency transforms, the at least one side gain being a prediction gain of a side transform from a mid transform of the at least one pair of mid/side transforms, and at least one corrected residual gain corresponding to at least one residual gain corrected by a residual gain correction parameter, the at least one residual gain being a function of an energy of a residual in a prediction of the side transform from the mid transform relative to an energy of the mid transform,

wherein the at least one side gain and the at least one residual gain are computed using the energies and the inner product of the at least one pair of ITD compensated frequency transforms.

12. Comparison method for a multi-channel audio signal comprising:

deriving, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensating the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

computing, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter, the at least one comparison parameter being computed using a function equaling or approximating an autocorrelation function of the analysis window and the at least one ITD parameter,

wherein the function equals or approximates a normalized version of the autocorrelation function of the analysis window, and the function is obtained by interpolation of the normalized version of the autocorrelation function of the analysis window stored in a look-up table.

13. Comparison method for a multi-channel audio signal comprising:

deriving, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensating the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

computing, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter including at least one side gain of at least one pair of mid/side transforms of the at least one pair of ITD compensated frequency transforms, the at least one side gain being a prediction gain of a side transform from a mid transform of the at least one pair of mid/side transforms, and at least one corrected residual gain corresponding to at least one residual gain corrected by a residual gain correction parameter, the at least one residual gain being a function of an energy of a residual in a prediction of the side transform from the mid transform relative to an energy of the mid transform, the at least one residual gain being corrected by an offset corresponding to the residual gain correction parameter $\hat{r}_t$ computed as $\hat{r}_t = \frac{2c}{c+1}\sqrt{2\frac{1-\widehat{W}_X(ITD_t)}{1+c^2+2c\widehat{W}_X(ITD_t)}}$, wherein c is a scaling gain between the audio signals of the at least one pair of channels and $\widehat{W}_X(n)$ is a function approximating a normalized version of the autocorrelation function of the analysis window.

14. Comparison method for a multi-channel audio signal comprising:

deriving, for an inter-channel time difference between audio signals for at least one pair of channels, at least one ITD parameter of the audio signals of the at least one pair of channels in an analysis window,

compensating the ITD for the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD compensated frequency transforms,

computing, based on the at least one ITD parameter and the at least one pair of ITD compensated frequency transforms, at least one comparison parameter, wherein

the at least one comparison parameter comprises at least one inter-channel coherence correction parameter for correcting an estimate of the ICC determined in the frequency domain of the at least one pair of audio signals based on the at least one ITD parameter.

15. Decoder for multi-channel audio signals configured to:

decode at least one downmix signal, at least one inter-channel time difference parameter and at least one comparison parameter computed using a method of any of claims 11 to 14,

upmix the at least one downmix signal for restoring the audio signals of at least one pair of channels from the at least one downmix signal using the at least one comparison parameter to generate at least one pair of decoded ITD compensated frequency transforms,

decompensate the ITD for the at least one pair of decoded ITD compensated frequency transforms of the at least one pair of channels in the frequency domain by circular shift using the at least one ITD parameter to generate at least one pair of ITD decompensated decoded frequency transforms for reconstructing the ITD of the audio signals of the at least one pair of channels in the time domain,

inverse frequency transform the at least one pair of ITD decompensated decoded frequency transforms to generate at least one pair of decoded audio signals of the at least one pair of channels.