Claims

1. Apparatus for estimating an inter-channel time difference between a first channel signal and a second channel signal, comprising:

a calculator for calculating a cross-correlation spectrum for a time block from the first channel signal in the time block and the second channel signal in the time block;

a spectral characteristic estimator for estimating a characteristic of a spectrum of the first channel signal or the second channel signal for the time block;

a smoothing filter for smoothing the cross-correlation spectrum over time using the spectral characteristic to obtain a smoothed cross-correlation spectrum; and

a processor for processing the smoothed cross-correlation spectrum to obtain the inter-channel time difference.

2. Apparatus of claim 1,

wherein the processor is configured to normalize the smoothed cross-correlation spectrum using a magnitude of the smoothed cross-correlation spectrum.

3. Apparatus of claim 1 or 2,

wherein the processor is configured

to calculate a time-domain representation of the smoothed cross-correlation spectrum or a normalized smoothed cross-correlation spectrum; and

to analyze the time-domain representation to determine the inter-channel time difference.

4. Apparatus of one of the preceding claims,

wherein the processor is configured to low-pass filter the time-domain representation and to further process a result of the low-pass filtering.

5. Apparatus of one of the preceding claims,

wherein the processor is configured to perform the inter-channel time difference determination by performing a peak searching or peak picking operation within a time-domain representation determined from the smoothed cross-correlation spectrum.

6. Apparatus of one of the preceding claims,

wherein the spectral characteristic estimator is configured to determine, as the spectral characteristic, a noisiness or a tonality of the spectrum; and

wherein the smoothing filter is configured to apply a stronger smoothing over time with a first smoothing degree in case of a first less noisy characteristic or a first more tonal characteristic, or to apply a weaker smoothing over time with a second smoothing degree in case of a second more noisy characteristic or a second less tonal characteristic,

wherein the first smoothing degree is greater than the second smoothing degree, and wherein the first noisy characteristic is less noisy than the second noisy characteristic, or the first tonal characteristic is more tonal than the second tonal characteristic.

7. Apparatus of one of the preceding claims,

wherein the spectral characteristics estimator is configured to calculate, as the characteristic, a first spectral flatness measure of a spectrum of the first channel signal and a second spectral flatness measure of a second spectrum of the second channel signal, and to determine the characteristic of the spectrum from the first and the second spectral flatness measure by selecting a maximum value, by determining a weighted average or an unweighted average between the spectral flatness measures, or by selecting a minimum value.

8. Apparatus of one of the preceding claims,

wherein the smoothing filter is configured to calculate a smoothed cross-correlation spectrum value for a frequency by a weighted combination of the cross-correlation spectrum value for the frequency from the time block and a cross-correlation spectral value for the frequency from at least one past time block, wherein weighting factors for the weighted combination are determined by the characteristic of the spectrum.

9. Apparatus of one of the preceding claims,

wherein the processor is configured to determine a valid range and an invalid range within a time-domain representation derived from the smoothed cross-correlation spectrum,

wherein at least one maximum peak within the invalid range is detected and compared to a maximum peak within the valid range, wherein the inter-channel time difference is only determined, when the maximum peak within the valid range is greater than at least one maximum peak within the invalid range.

10. Apparatus of one of the preceding claims,

wherein the processor is configured

to perform a peak search operation within a time-domain representation derived from the smoothed cross-correlation spectrum,

to determine a variable threshold from the time-domain representation; and

to compare a peak to the variable threshold, wherein the inter-channel time difference is determined as a time lag associated with a peak being in a predetermined relation to the variable threshold.

11. Apparatus of claim 10,

wherein the processor is configured to determine the variable threshold as a value being equal to an integer multiple of a value among the largest 10 % of values of the time-domain representation.

12. Apparatus of one of claims 1 to 9,

wherein the processor is configured to determine a maximum peak amplitude in each subblock of a plurality of subblocks of a time-domain representation derived from the smoothed cross-correlation spectrum,

wherein the processor is configured to calculate a variable threshold based on a mean peak magnitude derived from the maximum peak magnitudes of the plurality of subblocks, and

wherein the processor is configured to determine the inter-channel time difference as a time lag value corresponding to a maximum peak of the plurality of subblocks being greater than the variable threshold.

13. Apparatus of claim 12,

wherein the processor is configured to calculate the variable threshold by a multiplication of the mean threshold determined as an average peak among the peaks in the subblocks and a value,

wherein the value is determined by an SNR (signal to noise ratio) characteristic of the first and the second channel signal, wherein a first value is associated with a first SNR value and a second value is associated with a second SNR value, wherein the first value is greater than the second value, and wherein the first SNR value is greater than the second SNR value.

14. Apparatus of claim 13,

wherein the processor is configured to use a third value being lower than the second value in case of a third SNR value being lower than the second SNR value and when a difference between the threshold and a maximum peak is lower than a predetermined value.

15. Method for estimating an inter-channel time difference between a first channel signal and a second channel signal, comprising:

calculating a cross-correlation spectrum for a time block from the first channel signal in the time block and the second channel signal in the time block;

estimating a characteristic of a spectrum of the first channel signal or the second channel signal for the time block;

smoothing the cross-correlation spectrum over time using the spectral characteristic to obtain a smoothed cross-correlation spectrum; and

processing the smoothed cross-correlation spectrum to obtain the inter-channel time difference.

16. Computer program for performing, when running on a computer or a processor, the method of claim 15.