According to an embodiment, the pitch lag estimator may, e.g., be configured to determine the estimated pitch lag p according to $p = a + b \cdot i$.

In an embodiment, the pitch lag estimator may, e.g., be configured to estimate the estimated pitch lag depending on the plurality of original pitch lag values and depending on a plurality of time values as the plurality of information values, wherein for each original pitch lag value of the plurality of original pitch lag values, a time value of the plurality of time values is assigned to said original pitch lag value.

According to an embodiment, the pitch lag estimator may, e.g., be configured to estimate the estimated pitch lag by minimizing an error function.

In an embodiment, the pitch lag estimator may, e.g., be configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{k} time_{passed}(i) \cdot ((a + b \cdot i) - P(i))^2 ,$$

wherein a is a real number, wherein b is a real number, wherein k is an integer with $k \geq 2$, and wherein P(i) is the i-th original pitch lag value, wherein $time_{passed}(i)$ is the i-th time value being assigned to the i -th pitch lag value P(i).

According to an embodiment, the pitch lag estimator may, e.g., be configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{4} time_{passed}(i) \cdot ((a + b \cdot i) - P(i))^2 ,$$

wherein a is a real number, wherein b is a real number, wherein $P(i)$ is the i-th original pitch lag value, wherein $time_{passed}(i)$ is the i-th time value being assigned to the i -th pitch lag value P(i).

In an embodiment, the pitch lag estimator is configured to determine the estimated pitch lag p according to $p = a + b \cdot i$.

In an embodiment, the pitch lag estimator 120 may, e.g., be configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{4} g_p(i) \cdot ((a + b \cdot i) - P(i))^2 \quad ,$$

wherein a is a real number, wherein b is a real number, wherein P(i) is the i-th original pitch lag value, wherein $g_p(i)$ is the i-th pitch gain value being assigned to the i -th pitch lag value P(i).

According to an embodiment, the pitch lag estimator 120 may, e.g., be configured to determine the estimated pitch lag p according to $p = a + b \cdot i$.

In an embodiment, the pitch lag estimator 120 may, e.g., be configured to estimate the estimated pitch lag depending on the plurality of original pitch lag values and depending on a plurality of time values as the plurality of information values, wherein for each original pitch lag value of the plurality of original pitch lag values, a time value of the plurality of time values is assigned to said original pitch lag value.

According to an embodiment, the pitch lag estimator 120 may, e.g., be configured to estimate the estimated pitch lag by minimizing an error function.

In an embodiment, the pitch lag estimator 120 may, e.g., be configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{k} time_{passed}(i) \cdot ((a + b \cdot i) - P(i))^2 \quad ,$$

wherein a is a real number, wherein b is a real number, wherein k is an integer with $k \geq 2$, and wherein P(i) is the i-th original pitch lag value, wherein $time_{passed}(i)$ is the i-th time value being assigned to the i -th pitch lag value P(i).

According to an embodiment, the pitch lag estimator 120 may, e.g., be configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{4} time_{passed}(i) \cdot ((a + b \cdot i) - P(i))^2 \quad ,$$

wherein a is a real number, wherein b is a real number, wherein $P(i)$ is the i-th original pitch lag value, wherein $time_{passed}(i)$ is the i-th time value being assigned to the i -th pitch lag value P(i).

In an embodiment, the pitch lag estimator 120 is configured to determine the estimated pitch lag p according to $p = a + b \cdot i$.

In the following, embodiments providing weighted pitch prediction are described with respect to formulae (20) – (24b).

At first, weighted pitch prediction embodiments employing weighting according to the pitch gain are described with reference to formulae (20) – (22c). According to some of these embodiments, to overcome the drawback of the prior art, the pitch lags are weighted with the pitch gain to perform the pitch prediction.

In some embodiments, the pitch gain may be the adaptive-codebook gain g_p as defined in the standard G.729 (see [ITU12], in particular chapter 3.7.3, more particularly formula (43)). In G.729, the adaptive-codebook gain is determined according to:

$$g_p = \frac{\sum_{n=0}^{39} x(n)\, y(n)}{\sum_{n=0}^{39} y(n)\, y(n)} \qquad \text{bounded by } 0 \leq g_p \leq 1.2$$

There, $x(n)$ is the target signal and $y(n)$ is obtained by convolving $v(n)$ with $h(n)$ according to:

$$y(n) = \sum_{i=0}^{n} v(i)\, h(n-i) \quad n = 0,\ldots,39$$

wherein $v(n)$ is the adaptive-codebook vector, wherein $y(n)$ the filtered adaptive-codebook vector, and wherein $h(n - i)$ is an impulse response of a weighted synthesis filter, as defined in G.729 (see [ITU12]).

Claims

1. An apparatus for determining an estimated pitch lag, comprising:

an input interface for receiving a plurality of original pitch lag values, and

a pitch lag estimator for estimating the estimated pitch lag by minimizing an error function,

wherein the pitch lag estimator is configured to estimate the estimated pitch lag depending on a plurality of original pitch lag values and depending on a plurality of information values, wherein for each original pitch lag value of the plurality of original pitch lag values, an information value of the plurality of information values is assigned to said original pitch lag value.

2. An apparatus according to claim 1, wherein the pitch lag estimator is configured to estimate the estimated pitch lag depending on the plurality of original pitch lag values and depending on a plurality of pitch gain values as the plurality of information values, wherein for each original pitch lag value of the plurality of original pitch lag values, a pitch gain value of the plurality of pitch gain values is assigned to said original pitch lag value.

3. An apparatus according to claim 2, wherein each of the plurality of pitch gain values is an adaptive codebook gain.

4. An apparatus according to one of claims 1 to 3, wherein the pitch lag estimator is configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{k} g_p(i) \cdot ((a + b \cdot i) - P(i))^2 \quad ,$$

wherein a is a real number,

wherein b is a real number,

wherein k is an integer with $k \geq 2$, and

wherein $P(i)$ is the i-th original pitch lag value,

wherein $g_p(i)$ is the i-th pitch gain value being assigned to the i -th pitch lag value $P(i)$.

5. An apparatus according to claim 4, wherein the pitch lag estimator is configured to estimate the estimated pitch lag by determining the two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{4} g_p(i) \cdot ((a + b \cdot i) - P(i))^2 .$$

6. An apparatus according to claim 4, wherein the pitch lag estimator is configured to determine the estimated pitch lag p according to

$p = a \cdot i + b$.

7. An apparatus according to claim 1, wherein the pitch lag estimator is configured to estimate the estimated pitch lag depending on the plurality of original pitch lag values and depending on a plurality of time values as the plurality of information values, wherein for each original pitch lag value of the plurality of original pitch lag values, a time value of the plurality of time values is assigned to said original pitch lag value.

8. An apparatus according to claim 7, wherein the pitch lag estimator is configured to estimate the estimated pitch lag by determining two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{k} time_{passed}(i) \cdot ((a + b \cdot i) - P(i))^2 ,$$

wherein a is a real number,

wherein b is a real number,

wherein k is an integer with $k \geq 2$, and

wherein $P(i)$ is the i-th original pitch lag value,

wherein $time_{passed}(i)$ is the i-th time value being assigned to the i -th pitch lag value $P(i)$.

9. An apparatus according to claim 8, wherein the pitch lag estimator is configured to estimate the estimated pitch lag by determining the two parameters a, b, by minimizing the error function

$$err = \sum_{i=0}^{4} time_{passed}(i) \cdot ((a + b \cdot i) - P(i))^2 .$$

10. An apparatus according to claim 8, wherein the pitch lag estimator is configured to determine the estimated pitch lag p according to

$p = a \cdot i + b.$

11. A system for reconstructing a frame comprising a speech signal, wherein the system comprises:

an apparatus according to claim 1 for determining an estimated pitch lag, and

an apparatus for reconstructing the frame, wherein the apparatus for reconstructing the frame is configured to reconstruct the frame depending on the estimated pitch lag,

wherein the estimated pitch lag is a pitch lag of the speech signal.

12. An system for reconstructing a frame according to claim 11,

wherein the reconstructed frame is associated with one or more available frames, said one or more available frames being at least one of one or more preceding frames of the reconstructed frame and one or more succeeding frames of the

reconstructed frame, wherein the one or more available frames comprise one or more pitch cycles as one or more available pitch cycles, and

wherein the apparatus for reconstructing the frame comprises

a determination unit for determining a sample number difference indicating a difference between a number of samples of one of the one or more available pitch cycles and a number of samples of a first pitch cycle to be reconstructed, and

a frame reconstructor for reconstructing the reconstructed frame by reconstructing, depending on the sample number difference and depending on the samples of said one of the one or more available pitch cycles, the first pitch cycle to be reconstructed as a first reconstructed pitch cycle,

wherein the frame reconstructor is configured to reconstruct the reconstructed frame, such that the reconstructed frame completely or partially comprises the first reconstructed pitch cycle, such that the reconstructed frame completely or partially comprises a second reconstructed pitch cycle, and such that the number of samples of the first reconstructed pitch cycle differs from a number of samples of the second reconstructed pitch cycle,

wherein the determination unit is configured to determine the sample number difference depending on the estimated pitch lag.

13. A method for determining an estimated pitch lag, comprising:

receiving a plurality of original pitch lag values, and

estimating the estimated pitch lag by minimizing an error function,

wherein estimating the estimated pitch lag is conducted depending on a plurality of original pitch lag values and depending on a plurality of information values, wherein for each original pitch lag value of the plurality of original pitch lag values, an information value of the plurality of information values is assigned to said original pitch lag value.

14. A computer program for implementing the method of claim 13 when being executed on a computer or signal processor.