Claims

1. An apparatus for reconstructing a frame comprising a speech signal as a reconstructed frame, said reconstructed frame being 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, wherein the apparatus comprises:

a determination unit ~~(210)~~ 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 ~~(220)~~ 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 ~~(220)~~ 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 frame reconstructor ~~(220)~~ is adapted to generate an intermediate frame depending on said one of the one or more available pitch cycles,

wherein the frame reconstructor ~~(220)~~ is adapted to generate the intermediate frame so that the intermediate frame comprises a first partial intermediate pitch cycle, one or more further intermediate pitch cylces, and a second partial intermediate pitch cycle,

wherein the first partial intermediate pitch cycle depends on one or more of the samples of said one of the one or more available pitch cycles, wherein each of the one or more further intermediate pitch cycles depends on all of the samples of said one of the one or more available pitch cycles, and wherein the second partial

intermediate pitch cycle depends on one or more of the samples of said one of the one or more available pitch cycles,

wherein the determination unit ~~(210)~~ is configured to determine a start portion difference number indicating how many samples are to be removed or added from the first partial intermediate pitch cycle, and wherein the frame reconstructor ~~(220)~~ is configured to remove one or more first samples from the first partial intermediate pitch cycle, or is configured to add one or more first samples to the first partial intermediate pitch cycle depending on the start portion difference number,

wherein the determination unit ~~(210)~~ is configured to determine for each of the further intermediate pitch cycles a pitch cycle difference number indicating how many samples are to be removed or added from said one of the further intermediate pitch cycles, and wherein the frame reconstructor ~~(220)~~ is configured to remove one or more second samples from said one of the further intermediate pitch cycles, or is configured to add one or more second samples to said one of the further intermediate pitch cycles depending on said pitch cycle difference number, and

wherein the determination unit ~~(210)~~ is configured to determine an end portion difference number indicating how many samples are to be removed or added from the second partial intermediate pitch cycle, and wherein the frame reconstructor ~~(220)~~ is configured to remove one or more third samples from the second partial intermediate pitch cycle, or is configured to add one or more third samples to the second partial intermediate pitch cycle depending on the end portion difference number.

2. An apparatus according to claim 1,

wherein the determination unit is configured to determine a sample number difference for each of a plurality of pitch cycles to be reconstructed, such that the sample number difference of each of the pitch cycles indicates a difference between the number of samples of said one of the one or more available pitch cycles and a number of samples of said pitch cycle to be reconstructed, and

wherein the frame reconstructor ~~(220)~~ is configured to reconstruct each pitch cycle of the plurality of pitch cycles to be reconstructed depending on the sample number difference of said pitch cycle to be reconstructed and depending on the

samples of said one of the one or more available pitch cycles, to reconstruct the reconstructed frame.

3. An apparatus according to claim 1 or 2,

wherein the determination unit ~~(210)~~ is configured to determine a position of one or more pulses of the speech signal of the frame to be reconstructed as reconstructed frame, and

wherein the frame reconstructor ~~(220)~~ is configured to reconstruct the reconstructed frame depending on the position of the one or more pulses of the speech signal.

4. An apparatus according to one of the preceding claims,

wherein the determination unit ~~(210)~~ is configured to determine an index k of a last pulse of the speech signal of the frame to be reconstructed as the reconstructed frame such that

$$k = \left\lfloor \frac{L - s - T[0]}{T_r} - 1 \right\rfloor ,$$

wherein L indicates a number of samples of the reconstructed frame,

wherein s indicates a frame difference value,

wherein $T[0]$ indicates a position of a pulse of the speech signal of the frame to be reconstructed as the reconstructed frame, being different from the last pulse of the speech signal, and

wherein T_r indicates a rounded length of said one of the one or more available pitch cycles,

wherein the apparatus is configured to reconstruct the frame to be reconstructed as the reconstructed frame depending on the index k of the last pulse of the speech signal of the frame to be reconstructed as the reconstructed frame.

5. An apparatus according to one of the preceding claims,

wherein the determination unit ~~(210)~~ is configured to determine a rounded length T_r of said one of the one or more available pitch cycles based on formula:

$$T_r = \lfloor T_p + 0.5 \rfloor$$

wherein T_p indicates the length of said one of the one or more available pitch cycles,

wherein the apparatus is configured to reconstruct the frame to be reconstructed as the reconstructed frame depending on the rounded length T_r of said one of the one or more available pitch cycles.

6. An apparatus according to one of the preceding claims,

wherein the determination unit ~~(210)~~ is configured to determine a parameter s by applying the formula:

$$s = \delta \frac{L}{T_r} \frac{M+1}{2} - L\left(1 - \frac{T_p}{T_r}\right)$$

wherein T_p indicates the length of said one of the one or more available pitch cycles,

wherein T_r indicates a rounded length of said one of the one or more available pitch cycles,

wherein the frame to be reconstructed as the reconstructed frame comprises M subframes,

wherein the frame to be reconstructed as the reconstructed frame comprises L samples, and

wherein δ is a real number indicating a difference between a number of samples of said one of the one or more available pitch cycles and a number of samples of one of one or more pitch cycles to be reconstructed,

wherein the apparatus is configured to reconstruct the frame to be reconstructed as the reconstructed frame depending on the parameter s.

7. An apparatus according to one of the preceding claims,

wherein the apparatus is configured to reconstruct the frame to be reconstructed as the reconstructed frame depending on the formula:

$$\delta = \frac{T_{ext} - T_p}{M}$$

wherein the frame to be reconstructed as the reconstructed frame comprises M subframes,

wherein T_p indicates the length of said one of the one or more available pitch cycles, and

wherein T_{ext} indicates a length of one of the pitch cycles to be reconstructed of the frame to be reconstructed as the reconstructed frame.

8. An apparatus according to claim 1,

wherein the frame reconstructor is adapted to generate the intermediate frame so that the intermediate frame comprises the first partial intermediate pitch cycle, more than one further intermediate pitch cycles as the one or more further intermediate pitch cylces, and the second partial intermediate pitch cycle,

wherein the apparatus is configured to calculate the number of samples Δ_i to be removed from or added to each of the one or more further intermediate pitch cycles based on:

$$\Delta_i = |T_r - T_{ext}| - (k + 1 - i)a, 1 \leq i \leq k$$

wherein T_r indicates a rounded length of said one of the one or more available pitch cycles,

wherein T_{ext} indicates a length of one of the pitch cycles to be reconstructed of the frame to be reconstructed as the reconstructed frame,

wherein k indicates an index of a last pulse of the speech signal of the frame to be reconstructed as the reconstructed frame,

wherein i is an integer, and

wherein a is a number indicating a delta of the samples to be added or removed between consecutive pitch cycles.

9. An apparatus according to claim 8,

wherein the apparatus is configured to determine the number a according to

$$a = \frac{|T_r - T_{ext}|(L - s) - |s|T_r}{(k+1)\left(T[0] + \frac{k}{2}T_r\right)}$$

wherein L indicates a number of samples of the reconstructed frame,

wherein s indicates a frame difference value,

wherein $T[0]$ indicates a position of a pulse of the speech signal of the frame to be reconstructed as the reconstructed frame, being different from the last pulse of the speech signal.

10. An apparatus according to claim 9,

wherein the apparatus is configured to calculate the number of samples to be removed from or added to the first partial intermediate pitch cycle based on:

$$\Delta_0^p = (|T_r - T_{ext}| - (k+1)a)\frac{T[0]}{T_r}$$

wherein the apparatus is configured to calculate the number of samples to be removed from or added to the second partial intermediate pitch cycle based on:

$$\Delta_{k+1}^p = |s| - \Delta_0^p - \sum_{i=1}^{k} \Delta_i$$

11. A method for reconstructing a frame comprising a speech signal as a reconstructed frame, said reconstructed frame being 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, wherein the method comprises:

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

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 reconstructing the reconstructed frame is conducted, 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 method further comprises generating an intermediate frame depending on said one of the one or more available pitch cycles,

wherein generating the intermediate frame is conducted so that the intermediate frame comprises a first partial intermediate pitch cycle, one or more further intermediate pitch cylces, and a second partial intermediate pitch cycle,

wherein the first partial intermediate pitch cycle depends on one or more of the samples of said one of the one or more available pitch cycles, wherein each of the one or more further intermediate pitch cycles depends on all of the samples of said one of the one or more available pitch cycles, and wherein the second partial intermediate pitch cycle depends on one or more of the samples of said one of the one or more available pitch cycles,

wherein the method further comprises determining a start portion difference number indicating how many samples are to be removed or added from the first partial intermediate pitch cycle, and wherein the method further comprises removing one or more first samples from the first partial intermediate pitch cycle, or is configured to add one or more first samples to the first partial intermediate pitch cycle depending on the start portion difference number,

wherein the method further comprises determining for each of the further intermediate pitch cycles a pitch cycle difference number indicating how many samples are to be removed or added from said one of the further intermediate pitch cycles, and wherein the method further comprises removing one or more second samples from said one of the further intermediate pitch cycles, or is configured to add one or more second samples to said one of the further intermediate pitch cycles depending on said pitch cycle difference number, and

wherein the method further comprises determining an end portion difference number indicating how many samples are to be removed or added from the second partial intermediate pitch cycle, and wherein the method further comprises removing one or more third samples from the second partial intermediate pitch cycle, or is configured to add one or more third samples to the second partial intermediate pitch cycle depending on the end portion difference number.

12. A computer program for implementing the method of claim 11 when being executed on a computer or signal processor.