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Method and arrangement for transmitting speech signals.

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The invention relates to a transmission system comprising a transmitter, which transmitter includes a speech coder that has a memory arrangement for storing excitation signals, has a filter arrangement for filtering the excitation signals, has selection means for comparing a signal derived from the speech signal with the output
5 signal of the filter, and for selecting the optimum excitation signal, and which transmitter includes a detector for detecting speech pauses and for turning off at least parts of the speech coder when a speech pause is detected and means for transmitting the optimum excitation signal to a receiver, which receiver includes a speech decoder for recovering the optimum excitation signal and the speech signal.

10 Such a method is widely known, for example from the title of "Advances in Speech Coding" by Bishnu S. Atal, Vladimir Cuperman, Allen Gersho, more specifically, pages 69 to 79. This method is especially used in mobile radio for transmitting speech signals between a mobile station and a fixed station. The mobile station is generally battery-operated and, as the transmitter consumes the most power it
15 is known that this transmitter with associated components is turned off during speech pauses to save energy and extend the useful life of the batteries. Due to the highly complex structure of the speech coder, however, this speech coder requires considerable power, especially because all the memory locations of the memory arrangement are to be addressed for each speech frame and all the excitation signals, also termed excitation
20 vectors, are to be filtered to find the optimum excitation vector that provides, for example, the least energy in the difference signal of the difference forming stage.

WO 93/13516, which describes an arrangement for the method defined in the opening paragraph but without giving details for the speech coder, has disclosed that the speech coder is turned off in speech pauses and only few parameters, *i.e.* LPC
25 coefficients and autocorrelation coefficients, are further produced, from which parameters the detector detects the speech pauses and from which parameters information is derived for background noise to be transmitted. There may then be assumed that also the filter arrangement in the speech coder is turned off, because the output signals thereof are not directly necessary during speech pauses. When, however,



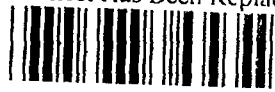
the speech signal recommences, the filter needs to have a certain time to build up to full intensity after being turned on, so that non-optimum parameters for the transmission of the speech signals occur during a transition period.

Therefore, it is an object of the invention to provide a transmission system
5 of the type defined in the opening paragraph, in which there can also be considerable power savings in speech pauses and in which optimum parameters for the transmission of the speech signals are available nearly forthwith when a speech signal recommences after a speech pause.

According to the invention this object is achieved in that the detector is
10 provided for turning off the selection means in the case of speech pauses and for applying to the filter a further signal derived from the speech signal.

According to the invented solution the addressing, reading and very costly filtering of all the stored excitation vectors is turned off when the selection means are turned off, because the addressing, reading and very costly filtering operations represent
15 the most computational circuitry, and only the function of the filter arrangement is maintained because this filter arrangement consumes little power. As the filter arrangement would no longer receive an input signal if the addressing of the memory arrangement were turned off, the filter arrangement receives a further signal derived from the speech signal, that is to say, only a single excitation vector, because ideally
20 the input signals of the two arrangements are to be the same. When the speech signal recommences after a speech pause, also the first filter arrangement will present a smoother transition to the complete speech coding then used again.

For obtaining optimum parameters for the transmission of the speech signals, it is known that the memory consists of a first sub-memory containing defined
25 excitation vectors and of a second sub-memory containing additional excitation vectors, which additional excitation vectors are formed not only by speech pauses, but also by the sum of a weighted excitation vector of the first sub-memory and a weighted excitation vector of the second sub-memory, and are written in the second sub-memory. The use of the additional excitation vectors provides that near-optimum excitation
30 vectors are obtained which produce a very small difference signal *i.e.* a small error signal. This is particularly effective in voiced speech sections, because then the speech signal is almost periodic and hardly ever changes abruptly. This is basically also the case when a speech signal recommences after a speech pause. Therefore, to have most



recent values as excitation values also in speech pauses, which most recent values can be used immediately after the speech signal has recommenced, it is suitable according to an embodiment of the invented method that during speech pauses the additional excitation vectors are taken off from the input of the first part of the second filter

5 arrangement and are written in the second sub-memory. As a result, additional excitation vectors are available in the second sub-memory when the speech signal is recommenced, which excitation vectors make it possible even at that instant to determine near-optimum parameters for the transmission of the speech signals.

An arrangement for executing the method according to the invention is
10 characterized in the further dependent claims.

Embodiments of the invention will be further explained hereinafter with reference to the drawings, in which

Fig. 1 shows a transmission system in which the invention can be used;

Fig. 2 shows a block circuit diagram of a speech coder in a transmitter
15 station; and

Fig. 3 shows the structure of the memory arrangement comprising two sub-memories.

In the transmission system shown in Fig. 1 a speech signal produced by a microphone 1 is transformed by the speech coder 4 in the transmitter 2 into a coded
20 speech signal. The coded speech signal is transmitted by the transmitter 2 to the receiver over the transmission link 3. The transmission link may be, for example, a radio link, a pair of copper wires or a glass fibre. In the receiver 5 the coded speech signal is transformed by the decoder into a reconstructed speech signal which is transformed into an acoustic signal by the loudspeaker 7.

25 The speech coder shown in Fig. 2 comprises a memory arrangement 12 which receives addresses and control signals from a control arrangement 14 over a link 15. The memory arrangement 12 contains different excitation vectors in a number of memory locations which are periodically and successively controlled and read by the control circuit 14. The excitation vectors that have been read appear on line 13 after a
30 weighting stage which is not shown here in detail, which line 13 is connected to a terminal of a change-over switch 28. This change-over switch is obviously an electronic switch. There is first assumed that the switch 28 is in the lower state, so that the excitation vectors which have been weighted and read on line 13 are applied to an input



29 of a first filter arrangement 16.

The digitized speech signal to be coded is applied to an input 11 which is connected to a filter 22. For clarity there is not shown an arrangement for deriving various parameters from the speech signal, especially for deriving LPC coefficients.

- 5 These LPC coefficients are applied to the filter 22 (LPC analysis filter) which filter, as a result, produces the so-called residual signal on line 23. Such residual signals also represent the excitation vectors stored in the memory arrangement 12.

- The residual signal on line 23 is applied to a filter 24 which has a like structure to filter arrangement 16 and also uses the same filter coefficients. The output
10 signals of filters 16 and 24 are applied to a difference forming stage 18 which forms the difference between the two signals and this difference signal is also denoted an error signal because this difference signal is a measure for the difference between the speech signal on input 11 and a speech signal recovered from the excitation vectors. This difference signal is applied to a processing unit 20 which forms the average energy of
15 the error signal. This average energy is applied over line 21 to the control circuit 14 which retains the address of the excitation vector for which the smallest average energy is found. This address is transmitted to the receiver station as a parameter of the speech signal to be transmitted.

- Furthermore, a detector 26 is provided which receives both the speech
20 signal applied to the input 11 and the residual signal produced on line 23 and, on the basis thereof, decides whether there is a real speech signal on input 11 or whether at that very moment there is a speech pause in which only the background noise is applied to the input 11. If the detector 26 detects a speech pause, a signal is transmitted over line 27, which signal turns off the selection means 10 formed by the control circuit 14,
25 the memory arrangement 12, the difference forming stage 18 and the processing arrangement 20. As in that case the filter arrangement 16 would no longer receive excitation vectors, however, the signal on line 27 also actuates the change-over switch 28, so that then the input 29 of the filter arrangement 16 is supplied with the residual signal on line 23. This signal largely corresponds to the optimum excitation vector
30 which is produced each time over the line 13, thus only a single excitation vector each time. If, after this, a speech signal again occurs on input 11 and the elements of selection means 10 are turned on again and the change-over switch 28 is returned to the lower state, the filter 16 receives over line 13 again all the stored and weighted

excitation vectors from which the optimum one is to be selected.

The input 29 of the filter 16 is further connected to a data input of the memory arrangement 12. As shown in Fig. 3 the memory arrangement 12 is actually formed by two sub-memories 121 and 122 which are driven by the control circuit 14 in Fig. 1 via respective address inputs 15a and 15b. The sub-memory 121 is generally a read-only memory which contains a number of fixedly stored excitation vectors. The sub-memory 122, on the other hand, is a random-access memory which receives on an input 126 the most recently produced optimum excitation vector from line 13. The excitation vector on line 13 is formed by a summator 125 which determines the sum of an excitation vector from the sub-memory 121, which is multiplied by a first weighting coefficient in a multiplier 124, and an excitation vector from the second sub-memory 122 which is multiplied by a generally different weighting coefficient in a further multiplier 123. The first sub-memory 121 may also comprise a plurality of read-only memories which are switched to in response to a detection of a voiced/voiceless element in the speech signal.

As the memory arrangement 12 in Fig. 1 is turned off during speech pauses, no excitation vectors will be generated on line 13 during that period of time. The data input 126 of the second sub-memory 122 in Fig. 3 is therefore directly connected to the input 29 of the filter arrangement 16, which input also receives a signal during speech pauses, *i.e.* the residual signal on line 23. In this manner the second sub-memory 122 contains the most recent excitation vectors also in speech pauses, so that when a speech signal is switched over to, practically simultaneously a sequence of near-optimum excitation vectors is received on line 13.

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Claims:

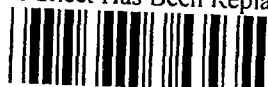
1. Transmission system comprising a transmitter, which transmitter includes a speech coder that has a memory arrangement for storing excitation signals, has a filter arrangement for filtering the excitation signals, has selection means for comparing a signal derived from the speech signal with the output signal of the filter, and for
5 selecting the optimum excitation signal, and which transmitter includes a detector for detecting speech pauses and for turning off at least parts of the speech coder when a speech pause is detected and means for transmitting the optimum excitation signal to a receiver, which receiver includes a speech decoder for recovering the optimum excitation signal and the speech signal, characterized in that the detector is provided for
10 turning off the selection means in the case of speech pauses and for applying to the filter a further signal derived from the speech signal.

2. Transmission system as claimed in Claim 1, characterized in that the memory comprises a first sub-memory for storing the predefined excitation signals and a second sub-memory for storing additional excitation signals, in that the speech coder
15 comprises means for writing in the second sub-memory and out of speech pauses the sum of a weighted excitation signal of the first sub-memory and a weighted excitation signal of the second sub-memory, and for writing in the second sub-memory and during speech pauses the further signal derived from the speech signal.

3. Transmitter for transmitting speech signals, comprising a speech coder
20 that has a codebook memory for storing excitation signals, has a filter arrangement for filtering the excitation signals, has selection means for comparing a signal derived from the speech signal with the output signal of the filter, and for selecting the optimum excitation signal, and which transmitter includes a detector for detecting speech pauses and for turning off at least parts of the speech coder when a speech pause is detected,
25 characterized in that the detector is provided for turning off the selection means in the case of speech pauses and for applying to the filter a further signal derived from the speech signal.

4. Transmitter as claimed in Claim 3, characterized in that the memory comprises a first sub-memory for storing the predefined excitation signals and a second

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sub-memory for storing additional excitation signals, in that the speech coder comprises means for writing in the second sub-memory and out of speech pauses the sum of a weighted excitation signal of the first sub-memory and a weighted excitation signal of the second sub-memory, and for writing in the second sub-memory and during speech
5 pauses the further signal derived from the speech signal.

5. Mobile radio set comprising a transmitter for transmitting speech signals, comprising a speech coder that has a memory for storing excitation signals, has a filter arrangement for filtering the excitation signals, has selection means for comparing a signal derived from the speech signal with the output signal of the filter, and for
10 selecting the optimum excitation signal, and which transmitter includes a detector for detecting speech pauses and for turning off at least parts of the speech coder when a speech pause is detected, characterized in that the detector is provided for turning off the selection means in the case of speech pauses and for applying to the filter a further signal derived from the speech signal.

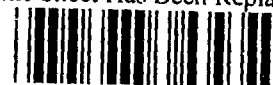
15 6. Mobile radio set as claimed in Claim 5, characterized in that the memory comprises a first sub-memory for storing the predefined excitation signals and a second sub-memory for storing additional excitation signals, in that the speech coder comprises means for writing in the second sub-memory and out of speech pauses the sum of a weighted excitation signal of the first sub-memory and a weighted excitation signal of
20 the second sub-memory, and for writing in the second sub-memory and during speech pauses the further signal derived from the speech signal.

7. Method of transmitting speech signals, which method includes storing excitation signals, filtering the excitation signals, comparing a signal derived from the speech signal with the filtered excitation signal, selecting the optimum excitation signal
25 and detecting speech pauses and turning off at least parts of the means for executing the method when a speech pause is detected, characterized in that the method further includes turning off the selection means when there is a speech pause and applying to the filter a further signal derived from the speech signal.

8. Method as claimed in Claim 7, characterized in that the memory
30 comprises a first sub-memory for storing the predefined excitation signals and a second sub-memory for storing additional excitation signals, in that the speech coder comprises means for writing in the second sub-memory and out of speech pauses the sum of a weighted excitation signal of the first sub-memory and a weighted excitation signal of



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the second sub-memory, and for writing in the second sub-memory and during speech pauses the further signal derived from the speech signal. comprises means for writing in the second sub-memory outside speech pauses the sum of a weighted excitation signal of the first sub-memory and a weighted excitation signal of the second sub-memory, and

5 for writing in the second sub-memory during speech pauses the further signal derived from the speech signal.

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