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DESCRIPTION

BACKGROUND OF THE INVENTION

1. Field of the Invention:

[0001] The present invention relates to a speech enhancement apparatus for enhancing rising portions of speech including consonants.

2. Description of the Related Art:

[0002] Figure 15 shows a basic configuration of a conventional speech enhancement apparatus. The speech enhancement apparatus includes an amplifier 101 for amplifying a speech signal, a gap detector 102 for detecting a silence component, an envelope follower 103 for following an envelope of the speech signal, a zero crossing detector 104 for determining the zero crossing frequency of the speech signal, and a differentiator 105 for determining the rate of change in the speech signal. The speech enhancement apparatus further includes a one-shot mono/multivibrator 106 which generates a pulse on the basis of the output from the gap detector 102, the differentiator 105, and the zero crossing detector 104 so as to control the amplifier 101.

[0003] The operation of such a conventional speech enhancement apparatus will be described with reference to Figures 16A to 16C. Figure 16A shows a waveform of an input speech signal. The input speech signal is sent to the amplifier 101, the gap detector 102, the envelope follower 103, and the zero crossing detector 104. The gap detector 102 detects a silence component of the received speech signal and outputs the result to the one-shot mono/multivibrator 106. The envelope follower 103 follows an envelope of the received speech signal and outputs the result to the differentiator 105. The differentiator 105 determines the rate of change in the envelope and outputs the result to the one-shot mono/multivibrator 106. The zero crossing detector 104 determines the zero crossing frequency of the received speech signal and outputs the result to the one-shot mono/multivibrator 106. Based on the outputs from the gap detector 102, the differentiator 105, and the zero crossing detector 104, the one-shot mono/multivibrator 106 generates a pulse having a waveform as shown in Figure 16B. The pulse is generated when a silence component of the speech signal shifts to a sound component thereof and lasts until both the zero crossing frequency and the rate of change in the envelope become sufficiently high. The pulse generated by the one-shot mono/multivibrator 106 is sent to the amplifier 101. On receipt of the pulse, the amplifier 101 amplifies the input speech signal with a predetermined amount of gain, and outputs an amplified speech signal having a waveform as shown in Figure 16C. When no pulse is sent to the amplifier 101, the original speech signal input to the amplifier 101 is output therefrom with a gain of 1 (one), i.e., without any amplification.

[0004] An example of a conventional speech enhancement apparatus can e.g. be found in EP-A1-076687.

[0005] Such a conventional speech enhancement apparatus amplifies only a specific consonant of the speech signal with the predetermined amount of gain, since the gain of the amplifier 101 is controlled based on a pulse output of the one-shot mono/multivibrator 106. The gain of the amplifier 101 drastically changes when the pulse output of the one-shot mono/multivibrator 106 is switched. This causes distortion. Further, the conventional speech enhancement apparatus amplifies consonants having different levels from each other with the same gain, since the gain of the amplifier 101 is predetermined. As a result, it is impossible to amplify various kinds of consonants to an appropriate level.

SUMMARY OF THE INVENTION

[0006] The apparatus for enhancing speech of this invention, includes: an input circuit for receiving a speech signal and for converting the speech signal into a speech signal; a rectifier coupled to the input circuit for rectifying the speech signal; a first time constant circuit coupled to the rectifier for applying a first time constant to the output of the rectifier; a second time constant circuit coupled to the rectifier for applying a second time constant to the output of the rectifier; the second time constant being different from the first time constant; a divider coupled to the first time constant circuit and the second time constant circuit for obtaining a ratio of the output of the first time constant circuit to the output of the second time constant circuit; a multiplier coupled to the input circuit and the divider for multiplying the speech signal by the ratio obtained by the divider; and an output circuit coupled to the multiplier for converting the output of the multiplier into speech.

[0007] In one embodiment of the invention, the first time constant is smaller than the second time constant.

[0008] In another embodiment of the invention, the divider outputs a signal of 1 (one) to the multiplier when the output of the second time constant circuit is zero.

[0009] In another embodiment of the invention, the apparatus further includes: a third time constant circuit coupled to the divider for applying a third time constant to the output of the divider, wherein the multiplier multiplies the speech signal by the output of the third time constant circuit.

[0010] In another embodiment of the invention, the apparatus further includes: a limiter coupled to the divider for limiting the output of the divider within a predetermined range defined by at least one of a lower limit and an upper limit, and wherein the multiplier multiplies the speech signal by the output of the limiter.

[0011] In another embodiment of the invention, the lower limit of the limiter is 1 (one).

[0012] In another embodiment of the invention, the
apparatus further includes: a third time constant circuit coupled to the divider for applying a third time constant to the output of the divider, and a limiter coupled to the third time constant circuit for limiting the output of the third time constant circuit within a predetermined range defined by at least one of a lower limit and an upper limit, and wherein the multiplier multiplies the speech signal by the output of the limiter.

[0013] In another embodiment of the invention, the lower limit of the limiter is 1 (one).

[0014] In another aspect of this invention, an apparatus for enhancing speech includes: an input circuit for receiving speech and for converting the speech into a speech signal; a rectifier coupled to the input circuit for rectifying the speech signal; a first time constant circuit coupled to the rectifier for applying a first time constant to the output of the rectifier; a second time constant circuit coupled to the rectifier for applying a second time constant to the output of the rectifier, the second time constant being different from the first time constant; a divider coupled to the first time constant circuit and the second time constant circuit for obtaining a ratio of the output of the first time constant circuit to the output of the second time constant circuit; a level detector coupled to the input circuit for detecting an instantaneous level of the speech signal; an average level detector coupled to the input circuit for detecting an average level obtained by averaging the speech signal for a predetermined time period; a comparator coupled to the level detector and the average level detector for obtaining the difference between the instantaneous level detected by the level detector and the average level detected by the average level detector, and for outputting a coefficient signal based on a comparison result of the difference and a predetermined threshold value; a third time constant circuit coupled to the comparator for applying a third time constant to the coefficient signal output from the comparator; a control circuit coupled to the divider and the third time constant circuit for selectively outputting one of the output of the divider and the output of the third time constant circuit based on the output of the third time constant circuit; a multiplier coupled to the input circuit and the control circuit for multiplying the speech signal by the output of the control circuit; and an output circuit coupled to the multiplier for converting the output of the multiplier into a speech.

[0018] In one embodiment of the invention, the first time constant is smaller than the second time constant.

[0019] In another embodiment of the invention, the divider outputs a signal of 1 (one) to the multiplier when the output of the second time constant circuit is zero.

[0020] According to the speech enhancement apparatus of the present invention, the difference between speech levels in the rising portion of the speech can be obtained by the use of different time constants. The speech sounds are enhanced based on the change of speech levels by amplifying the input speech by the use of the ratio of this difference. As a result, the rising portion of the speech including consonants is enhanced. Since the time constants change continuously, clear and natural speech can be output without distortion, even if the degree of amplification of the speech is drastically changed.

[0021] Thus, the invention described herein makes possible the advantage of providing a speech enhancement apparatus capable of controlling the gain smoothly with a simple process by determining a degree of amplification of the speech based on the change of the speech level.

[0022] This and other advantages of the present invention will become apparent to those skilled in the art upon reading and understanding the following detailed description with reference to the accompanying figures.
BRIEF DESCRIPTION OF THE DRAWINGS

[0023] Figure 1 is a block diagram of a first example of the speech enhancement apparatus according to the present invention.

[0024] Figures 2A to 2E are diagrams showing waveforms of a speech signal at different stages in the process by the first example of the speech enhancement apparatus according to the present invention.

[0025] Figure 3A is a diagram showing waveforms of original speech sounds and enhanced speech sounds.

[0026] Figure 3B is a diagram showing the actual relationship between the waveform of the speech and the level (or energy) of the speech.

[0027] Figure 4 is a block diagram of a second example of the speech enhancement apparatus according to the present invention.

[0028] Figures 5A to 5E are diagrams showing waveforms of a speech signal at different stages in the process by the second example of the speech enhancement apparatus according to the present invention.

[0029] Figure 6 is a block diagram of a third example of the speech enhancement apparatus according to the present invention.

[0030] Figures 7A to 7F are diagrams showing waveforms of a speech signal at different stages in the process by the third example of the speech enhancement apparatus according to the present invention.

[0031] Figures 8A to 8F are diagrams showing waveforms of a speech signal at different stages in the process by the third example of the speech enhancement apparatus according to the present invention.

[0032] Figure 9 is a block diagram of a fourth example of the speech enhancement apparatus according to the present invention.

[0033] Figures 10A to 10F are diagrams showing waveforms of a speech signal at different stages in the process by the fourth example of the speech enhancement apparatus according to the present invention.

[0034] Figure 11 is a block diagram of a fifth example of the speech enhancement apparatus according to the present invention.

[0035] Figures 12A to 12J are diagrams showing waveforms of a speech signal at different stages in the process by the fifth example of the speech enhancement apparatus according to the present invention.

[0036] Figure 13 is a block diagram of a sixth example of the speech enhancement apparatus according to the present invention.

[0037] Figures 14A to 14J are diagrams showing waveforms of a speech signal at different stages in the process by the sixth example of the speech enhancement apparatus according to the present invention.

[0038] Figure 15 is a block diagram of a conventional speech enhancement apparatus.

[0039] Figures 16A to 16C are diagrams showing waveforms of a speech signal at different stages in the process by the conventional speech enhancement app-

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0040] The present invention will be described by way of examples with reference to the accompanying drawings.

Example 1

[0041] Figure 1 shows the configuration of a first example of the speech enhancement apparatus according to the present invention. The speech enhancement apparatus includes an input circuit 10, a rectifier 11, a first time constant circuit 12, a second time constant circuit 13, a divider 14, a multiplier 15 and an output circuit 16.

[0042] The input circuit 10 receives a speech and then converts the received speech into an electric signal. In this specification, this electric signal is referred to as a "speech signal". The rectifier 11 rectifies the output of the input circuit 10. The first time constant circuit 12 applies a first time constant to the output of the rectifier 11. The second time constant circuit 13 applies a second time constant which is different from the first time constant to the output of the rectifier 11. The first and second time constants each is a parameter which determines the length of time in which a signal is changed from a predetermined level to another predetermined level.

[0043] The divider 14 divides the output of the first time constant circuit 12 by the output of the second time constant circuit 13 so as to calculate the ratio of the output of the first time constant circuit 12 to the output of the second time constant circuit 13. The multiplier 15 multiplies the output of the input circuit 10 by the output of the divider 14 so as to amplify the output of the input circuit 10 with the ratio calculated by the divider 14. The output circuit 16 converts the output of the multiplier 15 into speech.

[0044] Next, referring to Figures 2A to 2E, the operation of the speech enhancement apparatus of this example will be described.

[0045] Figures 2A to 2E show waveforms of the speech signal at points (a) to (e) shown in Figure 1. For simplicity of the explanation, it is assumed that the speech signal at point (a) has a rectangular-shaped waveform having a rising edge and a falling edge, as is shown in Figure 2A. This is because the present invention is characterized by the enhancement of the rising portion of the speech signal. However, the present invention can be applied to a speech signal having arbitrary waveform.

[0046] The input circuit 10 receives speech, and converts the received speech into a speech signal. The speech signal is supplied to the rectifier 11. The rectifier 11 performs a full-wave rectification of the speech signal so as to output the resultant speech signal to the first and second time constant circuits 12 and 13.
time constant to the output of the rectifier 11. The first time constant includes an attack time \( T_{a1} \) corresponding to the rising portion of the speech signal and a release time \( T_{r1} \) corresponding to the falling portion of the speech signal. The attack time \( T_{a1} \) is a time period (\( t_2 - t_1 \)) shown in Figure 2B, and the release time \( T_{r1} \) is a time period (\( t_4 - t_2 \)) shown in Figure 2B.

[0047] The second time constant circuit 13 applies a second time constant to the output of the rectifier 11. The second time constant includes an attack time \( T_{a2} \) corresponding to the rising portion of the speech signal and a release time \( T_{r2} \) corresponding to the falling portion of the speech signal as time constants. The attack time \( T_{a2} \) is a time period (\( t_3 - t_2 \)) shown in Figure 2C, and the release time \( T_{r2} \) is a time period (\( t_4 - t_3 \)) shown in Figure 2C.

[0048] These time constants satisfy the relationship of \( T_{a1} \leq T_{a2} \) and \( T_{r1} \leq T_{r2} \). In addition, it is preferable that the attack time \( T_{a1} \) is smaller than 30 msec. This is because there exists a feature of information of a consonant within 30 msec from the rising time \( t_1 \). It is preferable that the attack time \( T_{a2} \) is smaller than 50 msec. This is because, when the attack time \( T_{a2} \) is more than 50 msec, the influence of a vowel on the enhancement of the speech becomes too large, which prevents an appropriate enhancement of a consonant.

[0049] Figure 2B shows the waveform of the output of the first time constant circuit 12, and Figure 2C shows the waveform of the output of the second time constant circuit 13. Since the above-mentioned relationship is satisfied in time constants, the slope of the rising portion of the speech signal in Figure 2C is smaller than the slope of the rising portion of the speech signal in Figure 2B, and the slope of the falling portion of the speech signal in Figure 2C is smaller than the slope of the falling portion of the speech signal in Figure 2B.

[0050] If the output of the second time constant circuit 13 is not zero, the divider 14 calculates the ratio of the output of the first time constant circuit 12 to the output of the second time constant circuit 13, and outputs the calculated ratio to the multiplier 15. If the output of the second time constant circuit 13 is zero, the divider 14 outputs a constant coefficient of 1 (one) to the multiplier 15.

[0051] Figure 2D shows the waveform of the output of the divider 14. As is shown in Figure 2D, the output of the divider 14 (referred to as a "coefficient") is equal to 1 (one) at first, then gradually increases up to a peak level and comes back to 1 (one) after the peak level in response to the rising portion of the speech signal. The coefficient gradually decreases and comes back to 1 (one) in response to the falling portion of the speech signal.

[0052] The multiplier 15 multiplies the speech signal shown in Figure 2A by the coefficient shown in Figure 2D. As a result, a speech signal having an enhanced rising portion is obtained as the output of the multiplier 15, as is shown in Figure 2E. The output of the multiplier 15 is supplied to the output circuit 16. The output circuit 16 converts the output of the multiplier 15 into speech. Thus, speech having an enhanced rising portion of the input speech is output from the output circuit 16.

[0053] Figure 3A shows the waveform of an original speech which is input to the speech enhancement apparatus and the waveform of an enhanced speech which is output from the speech enhancement apparatus. The enhanced rising portion of the speech is indicated by an arrow. In this specification, "rising portion of the speech" is defined as a portion in which the level (or energy) of the speech is rising. The enhancement of the rising portion of the speech is very useful to improve the intelligibility of consonants, especially plosives such as /p/, /t/, /k/, /f/, /\theta/, and /\gamma/.

[0054] Figure 3B shows the actual relationship between the waveform of the speech and the level (or energy) of the speech.

[0055] Thus, according to the speech enhancement apparatus having the configuration mentioned above, the rising portion of the speech is enhanced based on the difference between the time constants. Since the time constants change continuously, the degree of amplification of the speech is not drastically changed. As a result, clear and natural speech can be obtained without distortion.

Example 2

[0056] Figure 4 shows the configuration of a second example of the speech enhancement apparatus according to the present invention. The second example is different from the first example in that a third time constant circuit 20 is inserted between the divider 14 and the multiplier 15. The output of the divider 14 is coupled to the third time constant circuit 20. The output of the third time constant circuit 20 is coupled to the multiplier 15. In Figure 4, the same components as the first example have the same reference numerals, and the explanation thereof will be omitted.

[0057] The third time constant circuit 20 applies a third time constant to the output of the divider 14. The third time constant includes an attack time \( T_{a3} \) corresponding to a rising portion of the speech signal and a release time \( T_{r3} \) corresponding to a falling portion of the speech signal. The attack time \( T_{a3} \) and the release time \( T_{r3} \) satisfy the relationship of \( T_{a3} \leq T_{r3} \). The attack time \( T_{a3} \) may be 0 msec.

[0058] Figures 5A to 5E show waveforms of the speech signal at points (a) to (e) shown in Figure 4. In Figure 5D, the solid line indicates the output of the third time constant circuit 20, and the broken line indicates the output of the divider 14.

[0059] Thus, according to the speech enhancement apparatus having the configuration mentioned above, the rising portion of the speech is enhanced based on the difference between the time constants. In addition, the duration of the enhancement can be controlled de-
pending on the third time constant. Since, in man cases, the rising portion of the speech includes a consonant and a vowel, it is possible to enhance the transition from the consonant to the vowel. As a result, clear and natural speech can be obtained.

Example 3

[0060] Figure 6 shows the configuration of a third example of the speech enhancement apparatus according to the present invention. The third example is different from the first example in that a limiter 21 is inserted between the divider 14 and the multiplier 15. The output of the divider 14 is coupled to the limiter 21. The output of the limiter 21 is coupled to the multiplier 15. In Figure 6, the same components as the first example have the same reference numerals, and the explanation thereof will be omitted.

[0061] The limiter 21 limits the output of the divider 14 within the range from a lower limit to an upper limit. For example, the upper limit is 5 and the lower limit is 1 (one).

[0062] Figures 7A to 7F show waveforms of the speech signal at points (a) to (f) shown in Figure 6. In Figure 7E, the solid line indicates the output of the limiter 21, and the broken line indicates the output of the divider 14.

[0063] Thus, according to the speech enhancement apparatus having the configuration mentioned above, the rising portion of the speech is enhanced based on the difference between the time constants. In addition, the excessive amplification of the rising portion of the speech can be avoided by the use of the upper limit of the limiter 21, and the attenuation of the speech can be avoided by the use of the lower limit of the limiter 21. Since, in many cases, the rising portion of the speech includes a consonant and a vowel, it is possible to avoid a different sound from the original which is caused by the excessive amplification of the consonant and to avoid the distortion which is caused by the attenuation of the vowel. As a result, clear and natural speech can be obtained.

[0064] Alternatively, the limiter 21 may only set the lower limit without setting the upper limit. For example, the lower limit is 1 (one). In this case, the attenuation of the speech can be avoided by the use of the lower limit of the limiter 21.

[0065] Figures 8A to 8F show waveforms of the speech signal at points (a) to (f) shown in Figure 6 in the case where the limiter 21 only sets the lower limit without setting the upper limit.

Example 4

[0066] Figure 9 shows the configuration of a fourth example of the speech enhancement apparatus according to the present invention. The fourth example is different from the first example in that a third time constant circuit and a limiter 21 are inserted between the divider 14 and the multiplier 15. Specifically, the fourth example is a combination of the second example with the third example. In Figure 9, the same components as the first example have the same reference numerals, and the explanation thereof will be omitted.

[0067] The third time constant circuit 20 applies a third time constant to the output of the divider 14. The third time constant includes an attack time $T_{a3}$ corresponding to a rising portion of the speech signal and a release time $T_{r3}$ corresponding to a falling portion of the speech signal. The attack time $T_{a3}$ and the release time $T_{r3}$ satisfy the relationship of $T_{a3} \leq T_{r3}$. The attack time $T_{a3}$ may be 0 msec.

[0068] The limiter 21 limits the output of the third time constant circuit 20 within the range from a lower limit to an upper limit. For example, the upper limit is 5 and the lower limit is 1 (one).

[0069] Figures 10A to 10F show waveforms of the speech signal at points (a) to (f) shown in Figure 9. In Figure 10D, a solid line indicates the output of the third time constant circuit 20, and a broken line indicates the output of the divider 14. In Figure 10E, a solid line indicates the output of the limiter 21, and a broken line indicates the output of the third time constant circuit 20.

[0070] Thus, according to the speech enhancement apparatus having the configuration mentioned above, the rising portion of the speech is enhanced based on the difference between the time constants. In addition, the duration of the enhancement can be controlled depending on the third time constant. The excessive amplification of the rising portion of the speech can be avoided by the use of the upper limit of the limiter 21, and the attenuation of the speech can be avoided by the use of the lower limit of the limiter 21. Since, in many cases, the rising portion of the speech includes a consonant and a vowel, it is possible to enhance the transition from the consonant to the vowel. It is also possible to avoid a different sound from the original which is caused by the excessive amplification of the consonant and to avoid the distortion which is caused by the attenuation of the vowel. As a result, a clear and natural speech can be obtained.

Example 5

[0071] Figure 11 shows the configuration of a fifth example of the speech enhancement apparatus according to the present invention. The fifth example is different from the first example in that a circuit for restraining an impulsive sound is added. The circuit includes a level detector 31 for detecting an instantaneous level of the output of the input circuit 10, an average level detector 32 for detecting an average level obtained by averaging the output of the input circuit 10 for a predetermined time period, a comparator 33 for comparing the difference between the output of the level detector 31 and the output of the average level detector 32 with a predeter-
minded threshold value so as to output the comparison result, a third time constant circuit 34 for applying a third time constant to the output of the comparator 33, and a control circuit 40 for controlling the selection of one of the output of divider 14 and the output of the third time constant circuit 34 depending on the output of the third time constant circuit 34. In Figure 11, the same components as the first example has the same reference numerals, and the explanation thereof will be omitted.

[0072] Next, referring to Figures 12A to 12J, the operation of the speech enhancement apparatus of this example will be described.

[0073] Figures 12A to 12J show waveforms of the speech signal at points (a) to (j) shown in Figure 11. For simplicity of the explanation, it is assumed that the impulsive sound and the speech signal at point (a) have a rectangular-shaped waveform having a rising edge and a falling edge, as is shown in Figure 12A. This is because the present invention is characterized by the enhancement of a rising portion of the speech signal. However, the present invention can be applied to a speech signal having arbitrary waveforms.

[0074] The input circuit 10 receives speech and then converts the received speech into an electric signal (i.e., speech signal). The speech signal is supplied to the rectifier 11, the level detector 31 and the average level detector 32.

[0075] The level detector 31 detects an instantaneous level of the speech signal, as is shown in Figure 12E. The average level detector 32 detects an average level obtained by averaging the speech signal for a predetermined time period, as is shown in Figure 12F. The instantaneous level detected by the level detector 31 and the average level detected by the average level detector 32 are supplied to the comparator 33.

[0076] The comparator 33 calculates the difference between the instantaneous level detected by the level detector 31 and the average level detected by the average level detector 32, and then compares the calculated difference with a predetermined threshold value. When the calculated difference is greater than or equal to the predetermined threshold value, the comparator 33 outputs a value smaller than 1 (one) to the third time constant circuit 34. For example, the value smaller than 1 (one) may be 0.3. However, the value smaller than 1 (one) is not limited to a fixed value. The value smaller than 1 (one) may change depending on the amplitude of the impulsive sound. When the calculated difference is smaller than the predetermined threshold value, the comparator 33 outputs a value of 1 (one) to the third time constant circuit 34. The output of the comparator 33 is shown in Figure 12G. The output of the comparator 33 is used as a coefficient in the multiplier 15, which described later.

[0077] The third time constant circuit 34 applies a third time constant to the coefficient output from the comparator 33. The third time constant includes an attack time $T_{a3}$ corresponding to a rising portion of the speech signal and a release time $T_{r3}$ corresponding to a falling portion of the speech signal. The attack time $T_{a3}$ and the release time $T_{r3}$ satisfy the relationship of $T_{a3} \leq T_{r3}$ in order for the coefficient to come back to 1 (one) smoothly. This is useful to avoid the occurrence of noises. The attack time $T_{a3}$ may be 0 msec. The output of the third time constant circuit 34 is shown in Figure 12H.

[0078] The control circuit 40 receives the coefficient from the divider 14 and the coefficient from the third time constant circuit 34. When the coefficient from the third time constant circuit 34 is smaller than 1 (one), the control circuit 40 outputs the coefficient from the third time constant circuit 34 to the multiplier 15. When the coefficient from the third time constant circuit 34 is equal to 1 (one), the control circuit 40 outputs the coefficient from the divider 14 to the multiplier 15. The output of the control circuit 40 is shown in Figure 12I.

[0079] The multiplier 15 receives the speech signal from the input circuit 10 and the coefficient from the control circuit 40, and multiplies the speech signal by the coefficient. The output of the multiplier 15 is shown in Figure 12J. The output of the multiplier 15 converted into speech by the output circuit 16. Thus, speech having an enhanced rising portion is obtained with a restrained impulsive sound.

[0080] Thus, according to the speech enhancement apparatus having the configuration mentioned above, the rising portion of the speech is enhanced based on the difference between the time constants. In addition, an impulsive sound is restrained by controlling the coefficient to the speech signal by control circuit 40. As a result, clear and natural speech can be obtained with a restrained impulsive sound.

Example 6

Figure 13 shows the configuration of a sixth example of the speech enhancement apparatus according to the present invention. The sixth example is different from the first example in that a circuit for restraining an impulsive sound is added. The circuit includes a third time constant circuit 50 for applying a third time constant to the output of the rectifier 11, a fourth time constant circuit 51 for applying a fourth time constant to the output of the rectifier 11, a comparator 52 for comparing the difference between the output of the third time constant circuit 50 and the output of the fourth time constant circuit 51 with a predetermined threshold value so as to output the comparison result, a fifth time constant circuit 53 for applying a fifth time constant to the output of the comparator 52, and a control circuit 40 for controlling to select one of the output of divider 14 and the output of the fifth time constant circuit 53 depending on the output of the fifth time constant circuit 53. In Figure 13, the same components as the first example have the same reference numerals, and the explanation thereof will be omitted.

[0082] Next, referring to Figures 14A to 14J, the op-
eration of the speech enhancement apparatus of this example will be described.

[0083] Figures 14A to 14J show waveforms of the speech signal at points (a) to (j) shown in Figure 13. For simplicity of the explanation, it is assumed that the impulsive sound and the speech signal at point (a) have a rectangular-shaped waveform having a rising edge and a falling edge, as is shown in Figure 14A. This is because the present invention is characterized by the enhancement of a rising portion of the speech signal. However, the present invention can be applied to a speech signal having arbitrary waveforms.

[0084] The input circuit 10 receives a speech, and then converts the received speech into an electric signal (i.e. speech signal). The speech signal is supplied to the rectifier 11. The rectifier 11 performs a full-wave rectification of the speech signal so as to output the resultant speech signal to the first, second, third and fourth time constant circuits 12, 13, 50 and 51.

[0085] The third time constant circuit 50 applies a third time constant to the output of the rectifier 11. The third time constant includes an attack time $T_{a3}$ corresponding to a rising portion of the speech signal and a release time $T_{r3}$ corresponding to a falling portion of the speech signal. The output of the third time constant circuit 50 is shown in Figure 14E.

[0086] The fourth time constant circuit 51 applies a fourth time constant to the output of the rectifier 11. The fourth time constant includes an attack time $T_{a4}$ corresponding to a rising portion of the speech signal and a release time $T_{r4}$ corresponding to a falling portion of the speech signal. The output of the fourth time constant circuit 51 is shown in Figure 14F.

[0087] The attack times $T_{a3}$ and $T_{a4}$ and the release times $T_{r3}$ and $T_{r4}$ satisfy the relationship of $T_{a3} < T_{a4}$ and $T_{r3} < T_{r4}$.

[0088] The comparator 52 calculates the difference between the output of the third time constant circuit 50 and the output of the fourth time constant circuit 51, and then compares the calculated difference with a predetermined threshold value. When the calculated difference is greater than or equal to the predetermined threshold value, the comparator 52 outputs a value smaller than 1 (one) to the fifth time constant circuit 53. For example, the value smaller than 1 (one) may be 0.3. However, the value smaller than 1 (one) is not limited to a fixed value. The value smaller than 1 (one) may change depending on the amplitude of the impulsive sound. When the calculated difference is smaller than the predetermined threshold value, the comparator 52 outputs a value of 1 (one) to the fifth time constant circuit 53. The output of the comparator 52 is shown in Figure 14G. The output of the comparator 52 is used as a coefficient in the multiplier 15, which described later.

[0089] The fifth time constant circuit 53 applies a fifth time constant to the coefficient output from the comparator 52. The fifth time constant includes an attack time $T_{a5}$ corresponding to a rising portion of the speech signal and a release time $T_{r5}$ corresponding to a falling portion of the speech signal. The attack time $T_{a5}$ and the release time $T_{r5}$ satisfy the relationship of $T_{a5} \leq T_{r5}$ in order for the coefficient to come back to 1 smoothly. This is useful to avoid the occurrence of noises. The attack time $T_{a5}$ may be 0 msec. The output of the fifth time constant circuit 53 is shown in Figure 14H.

[0090] The control circuit 40 receives the coefficient from the divider 14 and the coefficient from the fifth time constant circuit 53. When the coefficient from the fifth time constant circuit 53 is smaller than 1 (one), the control circuit 40 outputs the coefficient from the fifth time constant circuit 53 to the multiplier 15. When the coefficient from the fifth time constant circuit 53 is equal to 1 (one), the control circuit 40 outputs the coefficient from the divider 14 to the multiplier 15. The output of the control circuit 40 is shown in Figure 14I.

[0091] The multiplier 15 receives the speech signal from the input circuit 10 and the coefficient from the control circuit 40, and multiplies the speech signal by the coefficient. The output of the multiplier 15 is shown in Figure 14J. The output of the multiplier 15 is converted into a speech by the output circuit 16. Thus, speech having an enhanced rising portion is obtained with a restrained impulsive sound.

[0092] Thus, according to the speech enhancement apparatus having the configuration mentioned above, the rising portion of the speech is enhanced based on the difference between the time constants. In addition, an impulsive sound is restrained by controlling the coefficient to the speech signal by control circuit 40. As a result, clear and natural speech can be obtained with a restrained impulsive sound.

[0093] In examples 1 to 6, the rectifier 11 performs a full-wave rectification. However, the rectifier 11 may perform a half-wave rectification.

[0094] In examples 1 to 6, the release time $T_{r4}$ may be the same as the release time $T_{r3}$. In this case, the output of the divider 14 can become 1 (one) in the time corresponding to the falling portion of the speech after the attack time.

[0095] In example 5, when the calculated difference is greater than or equal to the predetermined threshold value, the comparator 33 outputs a value smaller than 1 (one) such as 0.3 to the third time constant circuit 34. However, the comparator may output arbitrary value which is greater than or equal to zero and is smaller than 1 (one) instead of the value smaller than 1 (one).

[0096] In example 6, when the calculated difference is greater than or equal to the predetermined threshold value, the comparator 52 outputs a value smaller than 1 (one) such as 0.3 to the fifth time constant circuit 53. However, the comparator may output arbitrary value which is greater than or equal to zero and is smaller than 1 (one) instead of the value smaller than 1 (one).

[0097] In example 5, the level detector 31 detects an instantaneous level of the speech signal, and the average level detector 32 detects an average level obtained
by averaging the speech signal for a predetermined time period. However, the level detector 31 may detect an average amplitude or an average energy for a short period and the average level detector 32 may detect an average amplitude or an average energy for a long period.

Claims

1. An apparatus for enhancing speech, comprising:

   input means (10) for receiving speech and for converting said speech into a speech signal; rectifying means (11) coupled to said input means for rectifying said speech signal; first time constant means (12) coupled to said rectifying means for applying a first time constant to the output of said rectifying means; second time constant means (13) coupled to said rectifying means for applying a second time constant to the output of said rectifying means; said second time constant being different from said first time constant; dividing means (14) coupled to said first time constant means and said second time constant means for obtaining a ratio of the output of said first time constant means to the output of said second time constant means; multiplying means (15) coupled to said input means and said dividing means for multiplying said speech signal by said ratio obtained by said dividing means; and output means (16) coupled to said multiplying means for converting the output of said multiplying means into speech.

2. An apparatus according to claim 1, wherein said first time constant is smaller than said second time constant.

3. An apparatus according to claim 1, wherein said dividing means outputs a signal of 1 to said multiplying means when the output of said second time constant means is zero.

4. An apparatus according to claim 1, further comprising:

   third time constant means (20) coupled to said dividing means for applying a third time constant to the output of said dividing means, and wherein said multiplying means multiplies said speech signal by the output of said third time constant means.

5. An apparatus according to claim 1, further comprising:

   limiting means (21) coupled to said dividing means for limiting the output of said dividing means within a predetermined range defined by at least one of a lower limit and an upper limit, and wherein said multiplying means multiplies said speech signal by the output of said limiting means.

6. An apparatus according to claim 5, wherein said lower limit of said limiting means is 1.

7. An apparatus according to claim 1, further comprising:

   third time constant means (20) coupled to said dividing means for applying a third time constant to the output of said dividing means, and limiting means (21) coupled to said third time constant means for limiting the output of said third time constant means within a predetermined range defined by at least one of a lower limit and an upper limit, and wherein said multiplying means multiplies said speech signal by the output of said limiting means.

8. An apparatus according to claim 7, wherein said lower limit of said limiting means is 1.

9. An apparatus for enhancing speech, comprising:

   input means (10) for receiving speech and for converting said speech into a speech signal; rectifying means (11) coupled to said input means for rectifying said speech signal; first time constant means (12) coupled to said rectifying means for applying a first time constant to the output of said rectifying means; second time constant means (13) coupled to said rectifying means for applying a second time constant to the output of said rectifying means; said second time constant being different from said first time constant; dividing means (14) coupled to said first time constant means and said second time constant means for obtaining a ratio of the output of said first time constant means to the output of said second time constant means; multiplying means (15) coupled to said input means and said dividing means for multiplying said speech signal by said ratio obtained by said dividing means; and output means (16) coupled to said multiplying means for converting the output of said multiplying means into speech.
sagtd input means for detecting an average level obtained by averaging said speech signal for a predetermined period of time; comparing means (33) coupled to said level detecting means and said average level detecting means for obtaining the difference between said instantaneous level detected by said level detecting means and said average level detected by said average level detecting means, and for outputting a coefficient signal based on the comparison result of said difference and a predetermined threshold value; third time constant means (34) coupled to said comparing means for applying a third time constant to said coefficient signal output from said comparing means; control means (40) coupled to said dividing means and said third time constant means for selectively outputting one of the output of said dividing means and the output of said third time constant means based on the output of said third time constant means; multiplying means (15) coupled to said input means and said control means for multiplying said speech signal by the output of said control means; and output means (16) coupled to said multiplying means for converting the output of said multiplying means into speech.

10. An apparatus according to claim 9, wherein said first time constant is smaller than said second time constant.

11. An apparatus according to claim 9, wherein said dividing means outputs a signal of 1 to said multiplying means when the output of said second time constant means is zero.

12. An apparatus for enhancing speech, comprising:

- input means (10) for receiving speech and for converting said speech into a speech signal;
- rectifying means (11) coupled to said input means for rectifying said speech signal;
- first time constant means (12) coupled to said rectifying means for applying a first time constant to the output of said rectifying means;
- second time constant means (13) coupled to said rectifying means for applying a second time constant to the output of said rectifying means, said second time constant being different from said first time constant;
- dividing means (14) coupled to said first time constant means and said second time constant means for obtaining a ratio of the output of said first time constant means to the output of said second time constant means;
- third time constant means (50) coupled to said rectifying means for applying a third time constant to the output of said rectifying means;
- fourth time constant means (51) coupled to said rectifying means for applying a fourth time constant to the output of said rectifying means, said fourth time constant being different from said third time constant;
- comparing means (52) coupled to said third time constant means and said fourth time constant means for obtaining the difference between the output of said third time constant means and the output of said fourth time constant means, and for outputting a coefficient signal based on the comparison result of said difference and a predetermined threshold value;
- fifth time constant means (53) coupled to said comparing means for applying a fifth time constant to said coefficient signal output from said comparing means;
- control means (40) coupled to said dividing means and said fifth time constant means for selectively outputting one of the output of said dividing means and the output of said fifth time constant means based on the output of said fifth time constant means;
- multiplying means (15) coupled to said input means and said control means for multiplying said speech signal by the output of said control means; and
- output means (16) coupled to said multiplying means for converting the output of said multiplying means into speech.

13. An apparatus according to claim 12, wherein said first time constant is smaller than said second time constant.

14. An apparatus according to claim 12, wherein said dividing means outputs a signal of 1 to said multiplying means when the output of said second time constant means is zero.

Patentansprüche

1. Vorrichtung zur Verbesserung bzw. Verstärkung von Sprache mit:

- einer Eingabevorrichtung (10) zum Aufnehmen bzw. Empfangen von Sprache und zum Umwandeln der Sprache in ein Sprachsignal;
- einer Gleichrichter(rectifying)-Vorrichtung (11), die mit der Eingabevorrichtung gekoppelt bzw. verschaltet ist, zum Gleichrichten des Sprachsignals;
- einer ersten Zeitkonstanten-Vorrichtung (12),
welche mit der Gleichrichter-Vorrichtung gekoppelt bzw. verschaltet ist, um eine erste Zeitkonstante bei der Ausgabe der Gleichrichter-
vorrichtung anzulegen;
einer zweiten Zeitkonstanten-Vorrichtung (13),
welche mit der Gleichrichter-Vorrichtung gekoppelt bzw. verschaltet ist, um eine zweite Zeitkonstante bei der Ausgabe der Gleichrich-
tervorrichtung anzulegen, wobei die zweite Zeitkonstante von der ersten Zeitkonstanten verschieden ist;
einer Teil-Vorrichtung (14), welche mit der ersten Zeitkonstanten-Vorrichtung und der zwei-
ten Zeitkonstanten-Vorrichtung gekoppelt bzw. verschaltet ist, um das Verhältnis der Ausgabe
der ersten Zeitkonstanten-Vorrichtung zu der Ausgabe der zweiten Zeitkonstanten-Vorrich-
tung zu erhalten;
einer Multiplikationsvorrichtung (15), welche mit der Eingabevorrichtung und der Teil-Vor-
richtung gekoppelt bzw. verschaltet ist, zum Multiplizieren des Sprach-Signals mit dem Ver-
hältnis, welches durch die Teil-Vorrichtung erhalten wurde, und
einer Ausgabevorrichtung (16), die mit der Multi-
plikations-Vorrichtung gekoppelt bzw. ver-
schaltet ist, zum Umwandeln der Ausgabe der Multiplikations-Vorrichtung in Sprache.

2. Vorrichtung nach Anspruch 1, wobei die erste Zeit-
konstante kleiner als die zweite Zeitkonstante ist.

3. Vorrichtung nach Anspruch 1, wobei die Teil-Vor-
richtung ein Signal von 1 zu der Multiplikationsvor-
richtung ausgibt, wenn die Ausgabe der zweiten Zeitkonstanten-Vorrichtung Null ist.

4. Vorrichtung nach Anspruch 1, weiter aufweisend:
eine dritte Zeitkonstanten-Vorrichtung (20),
welche mit der Teil-Vorrichtung gekoppelt bzw. verschaltet ist, zum Anlegen einer dritten Zeit-
konstanten bei der bzw. an die Ausgabe der Teilvorrichtung, und
wobei die Multiplikations-Vorrichtung das Sprachsignal mit der Ausgabe der dritten Zeit-
konstanten-Vorrichtung multipliziert.

5. Vorrichtung nach Anspruch 1, weiter aufweisend:
eine Begrenzungs-Vorrichtung (21), die mit der Teil-Vorrichtung gekoppelt bzw. verschaltet ist, zum Begrenzen der Ausgabe der Teil-Vorrichtung innerhalb eines vorgegebenen Bereichs, welcher durch mindestens eine untere Grenze und eine obere Grenze definiert ist,
55 wobei die Multiplikations-Vorrichtung das Sprachsignal mit der Ausgabe der Begren-
zungsvoerrichtung multipliziert.

6. Vorrichtung nach Anspruch 5, wobei die untere Grenze der Begrenzungsvoerrichtung 1 ist.

7. Vorrichtung nach Anspruch 1, weiter aufweisend:
eine dritte Zeitkonstanten-Vorrichtung (20), die mit der Teil-Vorrichtung gekoppelt bzw. ver-
schaltet ist, zum Anlegen einer dritten Zeitkonstanten an die Ausgabe der Teil-Vorrichtung; und
eine Begrenzungs-Vorrichtung (21), die mit der dritten Zeitkonstanten-Vorrichtung gekoppelt bzw. verschaltet ist, zum Begrenzen der Ausgabe der dritten Zeitkonstanten-Vorrichtung innerhalb eines vorgegebenen Bereichs, welcher durch mindestens eine untere Grenze und eine obere Grenze definiert ist, wobei die Multiplikations-Vorrichtung das Sprach-Signal mit der Ausgabe der Begren-
zungsvoerrichtung multipliziert.

8. Vorrichtung nach Anspruch 7, wobei die untere Grenze der Begrenzungsvoerrichtung 1 ist.

9. Vorrichtung zum Verstärken bzw. Verbessern von Sprache mit:
einer Eingabevorrichtung (10) zum Aufnehmen bzw. Empfangen von Sprache und zum Um-
wandeln der Sprache in ein Sprachsignal;
einer Gleichrichter(rectifying)-Vorrichtung (11), die mit der Eingabevorrichtung gekoppelt bzw. verschaltet ist, zum Gleichrichten des Sprach-
signals;
einer ersten Zeitkonstanten-Vorrichtung (12), welche mit der Gleichrichter-Vorrichtung gekoppelt bzw. verschaltet ist, um eine erste Zeit-
konstante bei der Ausgabe der Gleichrichter-
vorrichtung anzulegen;
einer zweiten Zeitkonstanten-Vorrichtung (13), welche mit der Gleichrichter-Vorrichtung gekoppelt bzw. verschaltet ist, um eine zweite Zeitkonstante bei der Ausgabe der Gleichrichter-
tervorrichtung anzulegen, wobei die zweite Zeitkonstante von der ersten Zeitkonstanten verschieden ist;
einer Teil-Vorrichtung (14), welche mit der ersten Zeitkonstanten-Vorrichtung und der zwei-
ten Zeitkonstanten-Vorrichtung gekoppelt bzw. verschaltet ist, um das Verhältnis der Ausgabe der ersten Zeitkonstanten-Vorrichtung zu der Ausgabe der zweiten Zeitkonstanten-Vorrichtung zu erhalten;
eine Pegel(level)-Erkennungsvoerrichtung (31), welche mit der Eingabe-Vorrichtung gekoppelt

10. Vorrichtung nach Anspruch 9, wobei die erste Zeitkonstante kleiner als die zweite Zeitkonstante ist.

11. Vorrichtung nach Anspruch 9, wobei die Teil-Vorrichtung ein Signal von 1 zu der Multiplikationsvorrichtung ausgibt, wenn die Ausgabe der zweiten Zeitkonstanten-Vorrichtung Null ist.

Verschaltet ist, zum selektiven Ausgeben der Ausgabe der Teil-Vorrichtung oder der Ausgabe der fünften Zeitkonstanten-Vorrichtung in Abhängigkeit von der Ausgabe der fünften Zeitkonstanten-Vorrichtung, einer Multiplikations-Vorrichtung (15), welche mit der Eingabe-Vorrichtung und der Regel- 
 bzw. Steuer-Vorrichtung gekoppelt bzw. verschaltet ist, zum Multiplizieren des Sprachsignals mit der Ausgabe der Regel- bzw. Steuer 
 vorrichtung; und einer Ausgabe-Vorrichtung (16), welche mit der Multiplikations-Vorrichtung gekoppelt bzw. verschaltet ist, zum Umdrehen der Ausgabe der Multiplikationsvorrichtung in Sprache.

13. Vorrichtung nach Anspruch 12, wobei die erste Zeitkonstante klein als die zweite Zeitkonstante ist.

14. Vorrichtung nach Anspruch 12, wobei die Teil-Vorrichtung ein Signal von 1 zu der Multiplikationsvorrichtung ausgibt, wenn die Ausgabe der zweiten Zeitkonstanten-Vorrichtung Null ist.

Revendications

1. Dispositif d'amélioration de la parole comprenant :
   un moyen d'entrée (10) destiné à recevoir la parole et à convertir ladite parole en un signal de parole ;
   un moyen de redressement (11) accouplé audit moyen d'entrée destiné à redresser ledit signal de parole ;
   un premier moyen à constante de temps (12) accouplé audit moyen de redressement destiné à appliquer une première constante de temps à la sortie dudit moyen de redressement ;
   un deuxième moyen à constante de temps (13) accouplé audit moyen de redressement destiné à appliquer une deuxième constante de temps à la sortie dudit moyen de redressement, ladite deuxième constante de temps étant différente de ladite première constante de temps ;
   un moyen de division (14) accouplé audit premier moyen à constante de temps et audit deuxième moyen à constante de temps destiné à obtenir un rapport entre la sortie dudit premier moyen à constante de temps et la sortie dudit deuxième moyen à constante de temps ;
   un moyen de multiplication (15) accouplé audit moyen d'entrée et audit moyen de division destiné à multiplier ledit signal de parole par ledit rapport obtenu par ledit moyen de division ; et un moyen de sortie (16) accouplé audit moyen de multiplication destiné à convertir en parole la sortie dudit moyen de multiplication.

2. Dispositif d'amélioration de la parole selon la revendication 1, dans lequel ladite première constante de temps est plus petite que ladite deuxième constante de temps.

3. Dispositif selon la revendication 1, dans lequel ledit moyen de division sort un signal de 1 vers ledit moyen de multiplication lorsque la sortie dudit deuxième moyen à constante de temps est zéro.

4. Dispositif selon la revendication 1, comprenant en outre :
   un troisième moyen à constante de temps (20) accouplé audit moyen de division destiné à appliquer une troisième constante de temps à la sortie dudit moyen de division, et dans lequel ledit moyen de multiplication multiplie ledit signal de parole par la sortie dudit troisième moyen à constante de temps.

5. Dispositif selon la revendication 1, comprenant en outre :
   un moyen de limitation (21) accouplé audit moyen de division destiné à limiter la sortie dudit moyen de division à l'intérieur d'une plage prédéterminée définie par au moins soit une limite inférieure et soit une limite supérieure, et dans lequel ledit moyen de multiplication multiplie ledit signal de parole par la sortie dudit moyen de limitation.

6. Dispositif selon la revendication 5, dans lequel la limite inférieure dudit moyen de limitation est 1.

7. Dispositif selon la revendication 1, comprenant en outre :
   un troisième moyen à constante de temps (20) accouplé audit moyen de division destiné à appliquer une troisième constante de temps à la sortie dudit moyen de division, et un moyen de limitation (21) accouplé audit troisième moyen à constante de temps destiné à limiter la sortie dudit moyen à constante de temps à l'intérieur d'une plage prédéterminée définie par au moins soit une limite inférieure et soit une limite supérieure, et dans lequel ledit moyen de multiplication multiplie ledit signal de parole par la sortie dudit moyen de limitation.

8. Dispositif selon la revendication 7, dans lequel la limite inférieure dudit moyen de limitation est 1.
9. Dispositif d'amélioration de la parole comprenant :

un moyen d'entrée (10) destiné à recevoir la parole et à convertir ladite parole en un signal de parole ;
un moyen de redressement (11) accouplé audit moyen d'entrée destiné à redresser ledit signal de parole ;
un premier moyen à constante de temps (12) accouplé audit moyen de redressement destiné à appliquer une première constante de temps à la sortie dudit moyen de redressement ;
un deuxième moyen à constante de temps (13) accouplé audit moyen de redressement destiné à appliquer une deuxième constante de temps à la sortie dudit moyen de redressement, ladite deuxième constante de temps étant différente de ladite première constante de temps ;
un moyen de division (14) accouplé audit premier moyen à constante de temps et audit deuxième moyen à constante de temps pour à obtenir un rapport entre la sortie dudit premier moyen à constante de temps et la sortie dudit deuxième moyen à constante de temps ;
un moyen de détection de niveau (31) accouplé audit moyen d'entrée pour détecter un niveau instantané dudit signal de parole ;
un moyen de détection de niveau moyen (32) accouplé audit moyen d'entrée pour détecter un niveau moyen obtenu en établissant la moyenne dudit signal de parole durant une période de temps prédéterminée ;
un moyen de comparaison (33) accouplé audit moyen de détection de niveau moyen et audit moyen de détection de niveau moyen pour obtenir la différence entre ledit niveau instantané détecté par ledit moyen de détection de niveau et ledit niveau moyen détecté par ledit moyen de détection de niveau moyen, et pour sortir un signal de coefficient fondé sur le résultat de la comparaison de ladite différence à une valeur de seuil prédéterminée ;
un troisième moyen à constante de temps (34) accouplé audit moyen de comparaison pour appliquer une troisième constante de temps audit signal de coefficient sorti dudit moyen de comparaison ;
un moyen de commande (40) accouplé audit moyen de division et audit troisième moyen à constante de temps pour sortir de façon sélective soit la sortie dudit moyen de division et soit la sortie dudit troisième moyen à constante de temps fondé sur la sortie dudit troisième moyen à constante de temps ;
un moyen de multiplication (15) accouplé audit moyen d'entrée et audit moyen de commande pour multiplier ledit signal de parole par la sortie dudit moyen de commande ; et
un moyen de sortie (16) accouplé audit moyen de multiplication pour convertir en parole la sortie dudit moyen de multiplication.

10. Dispositif selon la revendication 9, dans lequel la dite première constante de temps est plus petite que ladite deuxième constante de temps.

11. Dispositif selon la revendication 9, dans lequel ledit moyen de division sort un signal de 1 vers ledit moyen de multiplication lorsque la sortie dudit deuxième moyen à constante de temps est zéro.

12. Dispositif d'amélioration de la parole comprenant :

un moyen d'entrée (10) destiné à recevoir la parole et convertir ladite parole en un signal de parole ;
un moyen de redressement (11) accouplé audit moyen d'entrée pour redresser ledit signal de parole ;
un premier moyen à constante de temps (12) accouplé audit moyen de redressement pour appliquer une première constante de temps à la sortie dudit moyen de redressement ;
un deuxième moyen à constante de temps (13) accouplé audit moyen de redressement pour appliquer une deuxième constante de temps à la sortie dudit moyen de redressement, ladite deuxième constante de temps étant différente de ladite première constante de temps ;
un moyen de division (14) accouplé audit premier moyen à constante de temps et audit deuxième moyen à constante de temps pour obtenir un rapport entre la sortie dudit premier moyen à constante de temps et la sortie dudit deuxième moyen à constante de temps ;
un troisième moyen à constante de temps (50) accouplé audit moyen de redressement pour appliquer une troisième constante de temps à la sortie dudit moyen de redressement ;
un quatrième moyen à constante de temps (51) accouplé audit moyen de redressement pour appliquer une quatrième constante de temps à la sortie dudit moyen de redressement, ladite quatrième constante de temps étant différente de la troisième constante de temps ;
un moyen de comparaison (52) accouplé audit troisième moyen à constante de temps et audit quatrième moyen à constante de temps pour obtenir la différence entre la sortie dudit troisième moyen à constante de temps et la sortie dudit quatrième moyen à constante de temps, et pour sortir un signal de coefficient fondé sur le résultat de la comparaison de ladite différence à une valeur de seuil prédéterminée ;
un cinquième moyen à constante de temps (53)
accouplé audit moyen de comparaison pour appliquer une cinquième constante de temps audit signal de coefficient sorti dudit moyen de comparaison ;
un moyen de commande (40) accouplé audit moyen de division et audit cinquième moyen à constante de temps pour sortir de façon sélective soit la sortie dudit moyen de division et soit la sortie dudit cinquième moyen à constante de temps fondé sur la sortie dudit cinquième moyen à constante de temps ;
un moyen de multiplication (15) accouplé audit moyen d'entrée et audit moyen de commande pour multiplier ledit signal de parole par la sortie dudit moyen de commande ; et
un moyen de sortie (16) accouplé audit moyen de multiplication pour convertir en parole la sortie dudit moyen de multiplication en parole.

13. Dispositif selon la revendication 12, dans lequel la dite première constante de temps est plus petite que ladite deuxième constante de temps.

14. Dispositif selon la revendication 12, dans lequel ledit moyen de division sort un signal de 1 vers ledit moyen de multiplication lorsque la sortie dudit deuxième moyen à constante de temps est zéro.
FIG. 4

Input circuit

Rectifier

First time constant circuit

Divider

Third time constant circuit

Multiplier

Output circuit
FIG. 15

Speech input

Gap detector 102

Envelope follower 103

Differentiator 105

Zero crossing detector 104

Amplifier 101

One-shot mono/multi vibrator 106

Output