inserted into an input side of the adaptive filter to whiten the input signal (lower the autocorrelation) has been proposed as measures against entrainment (see, e.g., JP-T-2007-525917).

SUMMARY

The hearing aid of this disclosure includes a receiver configured to convert an electric signal into sound; a microphone configured to convert sound into an electric signal; an adaptive filter configured to adaptively estimate a feedback transfer function from the receiver to the microphone; a subtractor configured to subtract an output signal of the adaptive filter from an output signal of the microphone, thereby generating a first signal; a hearing aid processor configured to perform predetermined hearing aid processing for the first signal, thereby generating a second signal to be input to the receiver; a first whitening filter configured to whiten the first signal; a second whitening filter having a whitening filter coefficient identical to that of the first whitening filter and configured to whiten the second signal; a coefficient updater configured to update the coefficient of the adaptive filter based on each of output signals of the first and second whitening filters; and a controller configured to perform control of operation of the adaptive filter and the first and second whitening filters. The controller updates and saves a stabilization coefficient which is the coefficient of the adaptive filter obtained at a point in time in which the autocorrelation of the first signal is low, obtains the coefficient of the adaptive filter, determines the presence or absence of a change in the feedback transfer function based a difference or a ratio between the obtained coefficient of the adaptive filter and the stabilization coefficient, and performs, when it is determined that the feedback transfer function has changed, the control in order that effectiveness of whitening by the first and second whitening filters is reduced as compared to that when it is determined that the feedback transfer function does not change.

CLAIMS

1. A hearing aid comprising:

a receiver configured to convert an electric signal into sound;

a microphone configured to convert sound into an electric signal;

an adaptive filter configured to adaptively estimate a feedback transfer function from the receiver to the microphone;

a subtractor configured to subtract an output signal of the adaptive filter from an output signal of the microphone, thereby generating a first signal;

a hearing aid processor configured to perform predetermined hearing aid processing for the first signal, thereby generating a second signal to be input to the receiver;

a first whitening filter configured to whiten the first signal;

a second whitening filter having a whitening filter coefficient identical to that of the first whitening filter and configured to whiten the second signal;

a coefficient updater configured to update a coefficient of the adaptive filter based on each of output signals of the first and second whitening filters; and

a controller configured to perform control of operation of the adaptive filter and the first and second whitening filters,

wherein the controller

updates and saves a stabilization coefficient which is the coefficient of the adaptive filter obtained at a point of time in which an autocorrelation of the first signal is low,

obtains the coefficient of the adaptive filter,

determines a presence or absence of a change in the feedback transfer function based on a difference or a ratio between the obtained coefficient of the adaptive filter and the stabilization coefficient, and

performs, when it is determined that the feedback transfer function has changed, the control in order that effectiveness of whitening by the first and second whitening filters is

reduced as compared to that when it is determined that the feedback transfer function does not change.

2. The hearing aid according to claim 1, wherein each of the first and second whitening filters is an adaptive lattice filter with M number of stages, the adaptive lattice filter of each of the first and second whitening filters has M stage reflection coefficients, and the controller calculates an average of the M-stage reflection coefficients of either one of the first whitening filter or the second whitening filter, and updates the stabilization coefficient when it is, as a result of comparison between a preset first threshold and the average, determined that the average is smaller.

3. The hearing aid according to claim 1, wherein when it is determined that the feedback transfer function does not change, the controller performs the control in order that the effectiveness of whitening is at a predetermined level, and when it is determined that the feedback transfer function has changed, the controller performs the control in order that the effectiveness of whitening is lower than the predetermined level.

4. The hearing aid according to claim 1, wherein when it is determined that the feedback transfer function does not change, the controller actuates the whitening filters, and when it is determined that the feedback transfer function has changed, the controller stops operation of the whitening filters.

5. The hearing aid according to claim 1, wherein each of the whitening filters is an adaptive lattice filter with a predetermined number of stages, and each of the whitening filter coefficients is a reflection coefficient of the adaptive lattice filter.

6. The hearing aid according to claim 4, wherein the controller calculates a sum of differences, each of the differences being a difference between the obtained coefficient of the adaptive filter and the stabilization coefficient, and compares a preset second threshold with the sum of the differences to determine, according to a comparison result, the presence or absence of the change in the feedback transfer function.

7. The hearing aid according to claim 5, wherein the controller calculates a sum of differences, each of the differences being a difference between the obtained coefficient of the adaptive filter and the stabilization coefficient, and compares a preset second threshold with the sum of the differences to determine, according to a comparison result, the presence or absence of the change in the feedback transfer function.

8. The hearing aid according to claim 1, wherein when it is determined that the feedback transfer function has changed, the controller performs control to increase a convergence velocity of the adaptive filter in addition to the control to reduce the effectiveness of whitening by the whitening filters.

9. A feedback canceller comprising:

a first conversion device configured to convert an electric signal into sound;

a second conversion device configured to convert sound into an electric signal;

an adaptive filter configured to adaptively estimate a feedback transfer function from the first conversion device to the second conversion device;

a subtractor configured to subtract an output signal of the adaptive filter from an output signal of the second conversion device, thereby generating a first signal;

a signal processor configured to perform predetermined signal processing for the first signal, thereby generating a second signal to be input to the first conversion device;

a coefficient updater configured to update a coefficient of the adaptive filter; and

a controller configured to perform at least control of operation of the adaptive filter,

wherein the controller

updates and saves a stabilization coefficient which is the coefficient of the adaptive filter obtained at a point of time in which an autocorrelation of the first signal is low,

obtains the coefficient of the adaptive filter, and

determines a presence or absence of a change in the feedback transfer function based on a difference or a ratio between the obtained coefficient of the adaptive filter and the stabilization coefficient.

10. The feedback canceller according to claim 9, further comprising: a first whitening filter configured to whiten the first signal; and a second whitening filter having a whitening filter coefficient identical to that of the first whitening filter and configured to whiten the second signal, wherein the coefficient updater updates the coefficient of the adaptive filter based on each of output signals of the first and second whitening filters, and when it is determined that the feedback transfer function has changed, the controller performs the control in order that effectiveness of whitening by the first and second whitening filters is reduced as compared to that when it is determined that the feedback transfer function does not change.