Claims

What is claimed is:

1. A method of noise abatement within a signal stream containing unwanted signal referred to as noise, comprising:

acquiring a digitized noise signal from an environment in which the signal stream is present;

computing, by a digital processor circuit, a frequency domain representation of the digitized noise signal;

shifting the frequency domain representation of the digitized noise signal in time using the digital processor circuit, thereby producing a shifted frequency domain representation of the digitized noise signal where an amount of the shift in time is dependent on a selected frequency in the frequency domain representation and takes in account both an in-air propagation time of the noise signal and a system propagation time associated with the throughput speed of the digital processor circuit and any associated equipment, where the in-air propagation time is transit time for a signal to travel though air from an input microphone to a feedback microphone;

forming an anti-noise signal from the shifted frequency domain representation of the digitized noise signal in time domain; and

outputting the anti-noise signal into the signal stream to abate the noise through destructive interference.

2. The method of claim 1 wherein the shift in time of the frequency domain representation corresponds to a shift in the phase of the frequency domain representation.

3. The method of claim 1 further comprising individually shifting one or more noise segments in the frequency domain representation, where the frequency domain representation includes a plurality of noise segments and each noise segment in the plurality of noise segments correlates to a different frequency band.

4. The method of claim 3 further comprising

individually for each noise segment, applying an amplitude scaling factor appropriate for an application;

combining the plurality of shifted and amplitude-scaled noise segments to form a composite anti-noise signal.

5. The method of claim 4 wherein the size of each noise segment and the amplitude scaling factor is programmatically established by the digital processor circuit.

6. The method of claim 3 wherein the digital processor circuit is programmed to shift the phase of a noise segment.

7. The method of claim 3 wherein the digital processor circuit is programmed to shift the phase of a noise segment by an amount corresponding to a phase shift time calculated as an inverse of a product of two and the selected frequency for the noise segment.

8. The method of claim 1 wherein digital processor circuit is programmed to measure and calculate a system offset time that takes into account both a propagation time associated with the noise signal and a system propagation time associated with the throughput speed of the digital processor circuit and any associated equipment.

9. The method of claim 8 wherein the digital processor circuit is programmed to shift the phase of the frequency domain representation by an amount corresponding to a phase shift time calculated as an inverse of a product of two and the selected frequency and further adjusted by the system offset time.

10. The method of claim 9 wherein the digital processor circuit is programmed to adjust the anti-noise signal by an amplitude scaling factor.

11. The method of claim 1 wherein the digital processor circuit is programmed to shift the phase of the frequency domain representation by an amount corresponding to a phase shift time calculated as an inverse of product of two and the selected frequency for the frequency domain representation.

12. The method of claim 1 further comprising converting the anti-noise signal into an analog signal and outputting the anti-noise signal into the signal stream by mixing it with the noise within the signal stream.

13. The method of claim 12 further comprising mixing the anti-noise signal with the noise within the signal stream by using an amplified loudspeaker or other transducer disposed within the signal stream.

14. The method of claim 1 further comprising capturing the noise signal within the stream using at least one microphone coupled to an analog to digital converter to produce the acquired digitized noise signal.

15. The method of claim 1 further comprising:

acquiring a feedback signal by sampling the signal stream after outputting the anti-noise signal into the signal stream; and

processing the feedback signal using the digital processor circuit to adjust an amplitude and/or phase of the anti-noise signal to enhance abatement of the noise signal.

16. The method of claim 3 further comprising using the digital processor to subdivide the acquired noise signal by applying a Fourier transform to the acquired digitized audio noise signal and generating the plurality of noise segments in the frequency domain.

17. The method of claim 3 further comprising using the digital processor to subdivide the acquired noise signal by applying a convolution algorithm.

18. The method of claim 3 further comprising using the digital processor to subdivide the acquired noise signal by applying wavelet decomposition to subdivide the acquired noise signal into different frequency band segments and thereby generate a plurality of noise segments.

19. The method of claim 1 further comprising determining the system propagation time by:

acquiring a feedback signal by sampling the signal stream without outputting the anti-noise signal into the stream; and

using the digital processor to measure the time lapse between when the digitized noise signal is acquired and when the feedback signal is acquired and storing said difference in memory as the propagation time.

20. The method of claim 1 further comprising determining the system propagation time by

acquiring a feedback signal by sampling the signal stream after outputting the anti-noise signal into the stream; and

using the digital processor to measure the time lapse between when the digitized noise signal is acquired and when the feedback signal is acquired and storing said difference in memory as the propagation time.

21. A method of audio noise abatement in a personal device, comprising:

acquiring an information bearing signal;

acquiring a digitized noise signal;

using a digital processor circuit to subdivide the acquired noise signal into different frequency band segments and thereby generate a plurality of segmented noise signals;

individually shifting one or more segmented noise signals in time using the digital processor circuit, thereby producing a plurality of shifted segmented noise signals, where an amount of the shift in time is dependent on a selected frequency of the segmented noise signal and takes in account both an in-air propagation time of the noise signal and a system propagation time associated with the throughput speed of the digital processor circuit and any associated equipment, where the in-air propagation time is transit time for a signal to travel through air from an input microphone to a feedback microphone;

combining the plurality of shifted segmented noise signals to form a composite anti-noise signal;

mixing the anti-noise signal with the information bearing signal to abate the noise through destructive interference thereby producing an output signal; and

supplying the output signal to an audio playback transducer of the personal device.

22. The method of claim 21 wherein the shift in time of the segmented noise signal corresponds to a shift in the phase of the segmented noise signal.

23. The method of claim 21 wherein the shift in time of the segmented noise signal corresponds to a shift in time that compensates for a system offset time.

24. The method of claim 21 wherein the information bearing signal comprises at least one of entertainment content and voice.

25. The method of claim 21 where the audio playback transducer is a personal headset device or speaker mounted within the personal device.

26. A method of noise abatement in a signal processing system comprising,

acquiring a digitized noise signal;

using a digital processor circuit to subdivide the acquired noise signal into different frequency band segments and thereby generate a plurality of segmented noise signals;

storing the plurality of segmented noise signals in a memory;

acquiring an information bearing signal separate from the acquiring of the digitized noise signal;

processing the acquired information bearing signal by:

(a) retrieving the stored plurality of segmented noise signals from the memory

(b) individually shifting one or more segmented noise signals in time using the digital processor circuit, thereby producing a plurality of shifted segmented noise signals, where an amount of the shift in time is dependent on a selected frequency of the segmented noise signal and takes in account both an in-air propagation time of the noise signal and a system propagation time associated with the throughput speed of the digital processor circuit and any associated equipment, where the in-air propagation time is transit time for a signal to travel through air from an input microphone to a feedback microphone; and

(c) combining the plurality of shifted segmented noise signals with the acquired information bearing signal to abate the noise through destructive interference; and

outputting the processed acquired information bearing signal.

27. The method of claim 26 wherein the shift in time of the segmented noise signal corresponds to a shift in the phase of the segmented noise signal.

28. The method of claim 26 wherein the shift in time of the segmented noise signal corresponds to a shift in time that compensates for a system offset time.

29. A method of noise abatement of a noise producing device comprising:

acquiring a digitized representative noise signal of the noise producing device using a digital processor circuit to subdivide the acquired noise signal into different frequency band segments and thereby generate a plurality of segmented noise signals;

individually for each segmented noise signal, using the digital processor circuit to shift the phase of the segmented noise signal, thereby producing a plurality of shifted segmented noise signals, where an amount of the shift in time is dependent on a selected frequency of the segmented noise signal and takes in account both an in-air propagation time of the noise signal and a system propagation time associated with the throughput speed of the digital processor circuit and any associated equipment, where the in-air propagation time is transit time for a signal to travel through air from an input microphone to a feedback microphone;

combining the plurality of shifted segmented noise signals to form a composite anti-noise signal;

outputting the anti-noise signal into the signal stream to abate the noise through destructive interference.

30. The method of claim 29 wherein a noise signal associated with the noise producing device is captured over a predetermined period of time manipulated by calculating a moving average to obtain the representative noise signal.

31. A system for noise abatement in an audio signal stream which contains a noise signal, comprising:

a microphone configured to acquire a noise signal from an environment in which the audio signal stream is present;

an analog-to-digital converter configured to receive the noise signal from the microphone and operate to convert the noise signal to a digitized noise signal;

a digital signal processor configured to receive the digitized noise signal from the analog-to-digital converter and process the digitized noise signal by

computing a frequency domain representation of the digitized noise signal in frequency domain,

shifting the frequency domain representation of the digitized noise signal in time, thereby producing a shifted frequency domain representation of the digitized noise signal, where an amount of the shift in time takes in account both an in-air propagation time of the noise signal and a system propagation time associated with the throughput speed of the digital processor circuit and any associated equipment, where the in-air propagation time is transit time for a signal to travel through air from the microphone to a feedback microphone, and

forming an anti-noise signal from the shifted frequency domain representation of the digitized noise signal in time domain; and

a digital-to-analog converter configured to receive the anti-noise signal from the digital signal processor and operate to convert the anti-noise signal to an analog anti-noise signal.

32. The system of claim 31 further comprises a mixer configured to receive the audio signal stream and the analog anti-noise signal and operate to combine the audio signal stream with the analog anti-noise signal.