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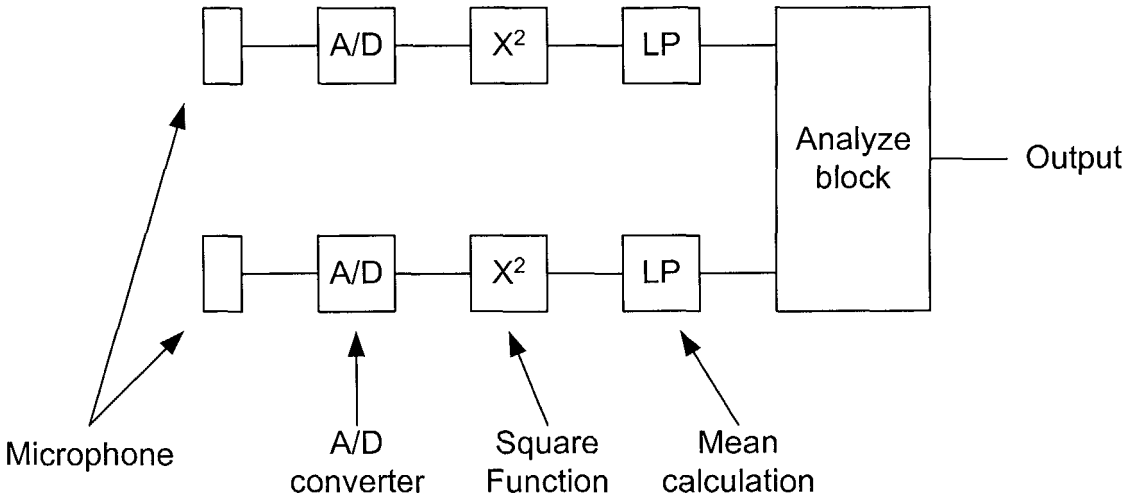
(54) Method for detection of ultrasound in a listening device with two or more microphones, and listening device with two or more microphones

(57) The invention concerns a method for detecting and minimizing the harmful influence of ultra sound in a listening device having two or more microphones. The energy contents in the microphone signals is determined, and time related changes in energy contents of the microphone signals is analysed to determine whether any of the microphones is subjected to an ultrasound soundfield, and the signal from the microphone with the lowest content of ultrasound is routed through a signal processing device to an output unit. The invention further concerns a listening device having means for choosing the microphone channel with the lowest level of ultrasound.



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Description

AREA OF THE INVENTION

[0001] The invention concerns a method for detection of ultra sound in a listening device and a listening device with a plurality of microphones wherein means are provided for detection of the presence of ultrasound.

BACKGROUND OF THE INVENTION

[0002] When a hearing aid is subject to an ultrasound field in the environment very annoying side effects may be experienced by the hearing aid user even if the ultrasound is at a frequency far above audio range of the human ear. One side effect is possible saturation of microphones and the analogue to digital converter of the apparatus. The saturation is a result of the very powerful sound pressures which are not un-common in connection with ultrasound devices like automatic dor-openers or alarm systems. Another side effect is caused by the non-linearity whereby the sound waves will often convolve down and result in the generation of sound in the audio frequency range, where people can hear it as noise. Also headsets or other listening devices having microphones may be adversely effected by the presence of ultrasound in the environment.

[0003] One way to reduce this effect is to use a ¼ wave resonator or other filter in the inlets before the microphones which reduces or removes the ultrasound before it reaches the microphone. This arrangement can be very costly because each microphone inlet must be modified to accommodate either the filter or the ¼ wave resonator, and further this complicates the production. Also filters may not in all instances be sufficient, in order to remove all harmful effects of the ultrasound sound field.

SUMMARY OF THE INVENTION

[0004] The invention concerns a method for detecting ultrasound and eliminating the harmful influence of ultra sound in a listening device having two or more microphones, whereby firstly the energy contents in the microphone signals is determined, and whereby time related changes in energy contents of the microphone signals is analysed to determine whether any of the microphones is subjected to an ultrasound sound-field, and whereby the signal from the microphone signal with the lowest content of ultrasound is routed through a signal processing device to an output unit.

[0005] When a listening device as a hearing aid with two or more microphones is placed in a ultrasound sound-field, the two microphone are often influenced quite differently by the ultra sound. Due to the very short wavelength of the ultrasound, one microphone port may be strongly influenced while the other port is hardly effected at all. This is used by the method in that the influence on the microphones of the ultrasound is monitored continuously and the signal from the microphone channel which is the least influenced by the ultra sound is routed to an output unit. The signal processing device is preferably a digital signal processing device and the output unit could be a receiver or other device externally or implanted into the ear or brain for providing a sensation of sound corresponding to the audio sounds in the environment.

[0006] In a further embodiment of the invention at least one microphone sound inlet is protected with an ultrasound protection device and at least one inlet is un-protected against ultrasound and further means are provided for detecting the presence of ultra sound. According to the invention the detection means detects the presence of ultrasound, and if ultrasound is present, then the signal from the protected microphone is routed to the output devcie.

[0007] If ultrasound is present, the power in the two channels will be different since the protected channel will attenuate the signal and the unprotected will not. By measuring the power in the two channels it is possible to detect the ultrasound signal, since we know which channel is protected. The energy in the protected channel will be lower than the energy in the unprotected channel. We also know that the energy in the signal is very powerful since the signal results in saturation of the microphones and/or the A/D converters. If the ultrasounds energy is lower than the saturation limit the sound will not result in any problems for the device. If ultrasound is measured the system automatically shifts to the signal from the channel with the protection.

[0008] In situations with no ultrasound the power in the two channels will be almost equal because the ultrasound protection only influence the high frequency area with ultrasound.

[0009] The invention also comprises a listening device with two or more microphones whereby the listening device has means for detecting the presence of ultrasound in at least one microphone channel.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

Fig. 1 shows the device to detect the ultrasound according to the invention

DESCRIPTION OF A PREFERRED EMBODIMENT

[0011] the microphones and the A/D converters delivers the input to the system. The following signal processing calculates a mean value of the energy in each microphone channel. The energy of each channel is forwarded into the analyse block. This block decides if the signal picked up by the microphones is ultra sound or not.

[0012] The analyse block looks at the energy contents in the signal from the microphone channels, and when the energy in one or more channels rises very fast above a given limit and reaches a value close to or at the sat-

uration limit, the signal from another microphone is routed to the hearing aid user. In this event any on-going directional- or other multi microphone algorithm must be terminated, and to this end a status value is routed from the analyse block to an overall control block of the listening device. Tests have shown that when a hearing aid or other listening device with microphones provided close to each other is moved about in an ultrasound sound field, at least one of the microphones will at most times be relatively un-affected by the ultra sound. This is quite un-expected, but as shown it is very useful, as it allows the user of the listening device to have at least one microphone functioning at most times also when the user is in a sound field of a ultrasound generator. Since the person is moving in the ultra sound field, and thereby changing the situation, the device must react fast. The purpose of the device is to use the microphone with the least amount of energy, when ultra sound is detected.

[0013] When a microphone with an ultrasound attenuation device is used the analyse block works in the following way:

1) detect if the energy in the unprotected microphone is above a given limit,
2) compare the energy from the two channels. If the energy in the unprotected channel is a given number of times X larger than the energy in the protected channel, then the output should be "ultrasound detected", and a corresponding status value routed to the digital signal processing unit.

[0014] Ad. 1) The limit value depends on the limit of saturation in a microphone. For a hearing aid microphone this limit is around 115-120 dB spl.
Ad. 2) The given number of times X depends on the efficiency of the ultrasound attenuation device provided at the at least one microphone.

[0015] When a microphone without an ultrasound attenuation device is used the analyse block works in the following way:

1) detect if the energy in one of the microphones is above a given limit,
2) compare the energy from the two channels. If the energy in the channel with the highest energy is a given number of times X larger than the energy in the other channel, the output should be "ultrasound detected", and a corresponding status value is routed to the digital signal processing unit.

[0016] Ad. 1) The limit value depends on the limit of saturation in a microphone. For hearing a aid microphone is this limit around 115-120 dB spl.
Ad. 2) The given number of times X depends on the efficiency of the ultrasound attenuation device provided at the at least one microphone.

[0017] The above example regards a device having two microphones, but the inventive concept is easily extended to devices having three or more microphones.

Claims

1. Method for detecting and minimizing the harmful influence of ultra sound in a listening device having two or more microphones, whereby the energy contents in the microphone signals is determined, and whereby time related changes in energy contents of the microphone signals is analysed to determine whether any of the microphones is subjected to an ultrasound sound-field, and whereby the signal from the microphone signal with the lowest content of ultrasound is routed through a signal processing device to an output unit.

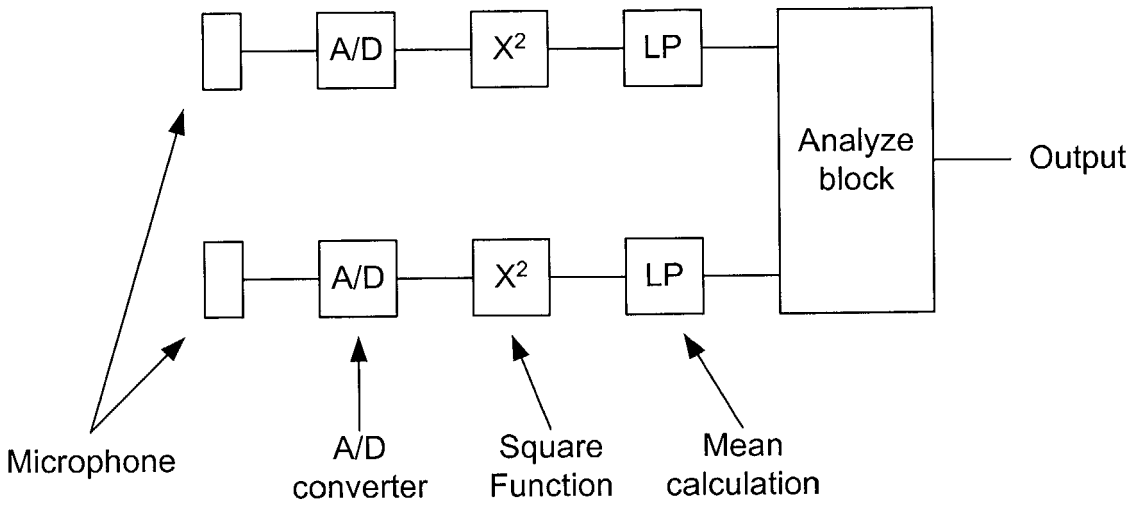
2. Method as claimed in claim 1, whereby at least one signal from a microphone without an ultrasound attenuation device is provided and whereby further at least one signal from a microphone with an ultrasound attenuation device is provided and whereby the signal energy content in the signals from the different microphones is analysed to determine whether the device is in a ultrasound soundfield, and whereby the signals from the microphone or microphones with the ultrasound attenuation devices is/are routed through a signal processing device to an output unit.

3. Listening device with two or more microphones each providing an electrical signal, a signal processing device and a receiver for delivering a signal to the user in order to provide a sensation of sound, whereby the signal processing device comprises means for calculating the energy content in the signal from each microphone and means for detecting the situation whereby the electrical signal from at least one of the microphones reaches an energy content close to or at the saturation point, whereby further the signal processing comprises means for routing the signal from a microphone channel with a lower energy content to the receiver.

4. Listening device as claimed in claim 3 whereby the microphones comprises inlet canals and whereby at least one of the microphone inlet canals comprises mechanical means for attenuating the ultrasound passing from the surrounding to the hearing aid and whereby further at least one microphone inlet canal is un-protected from the ultrasound energy, and whereby the means for routing the signal from a microphone channel is adapted to rout the signal from the channel comprising the mechanical attenuation means to the receiver.

5. Listening device as claimed in claim 4 whereby the mechanical means comprises a ¼ band resonator.

6. Listening device as claimed in claim 4 whereby the mechanical means comprises ultrasound attenuating filter material.


A/D
X2
LP
Analyze block
Output
A/D
X2
LP
Microphone
A/D converter
Square Function
Mean calculation

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 38 8075

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 01, 31 January 1996 (1996-01-31) -& JP 07 240990 A (SONY CORP), 12 September 1995 (1995-09-12) *abstract* -----	1-6	H04R29/00
X	PATENT ABSTRACTS OF JAPAN vol. 1996, no. 01, 31 January 1996 (1996-01-31) -& JP 07 240991 A (SONY CORP), 12 September 1995 (1995-09-12) *abstract* -----	1-6	
A	PATENT ABSTRACTS OF JAPAN vol. 006, no. 151 (E-124), 11 August 1982 (1982-08-11) -& JP 57 075100 A (SATO YASUO), 11 May 1982 (1982-05-11) *abstract* -----	1-6	
A	WO 2004/098232 A (OTICON A/S; BUERGER, CHRISTIAN, C; HANSEN, JON, PALLE; SKOVGAARD, JOER) 11 November 2004 (2004-11-11) * page 1, line 11 - page 4, line 21 * * figures 1-7 * -----	1-6	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H04R

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	20 April 2005	Meiser, J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 04 38 8075

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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20-04-2005

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82