(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 657 960 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
26.06.2013 Bulletin 2013/26

(51) Int Cl.:
H04R 25/00 *(2006.01)*

(21) Application number: **04388075.6**

(22) Date of filing: **16.11.2004**

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

Verfahren zur Ultraschalldetektion in einer Höreinrichtung sowie Höreinrichtung mit zwei oder mehr Mikrofonen

Méthode pour la détection ultrasonore dans un dispositif d'écoute et détecteur ultrasonore avec deux ou plusieurs microphones

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LU MC NL PL PT RO SE SI SK TR

(43) Date of publication of application:
17.05.2006 Bulletin 2006/20

(73) Proprietor: **OTICON A/S**
2765 Smørum (DK)

(72) Inventor: **Petersen, Kim Spetzler**
2900 Hellerup (DK)

(56) References cited:
EP-A1- 0 989 775 WO-A-2004/098232

- **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)**
- **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)**
- **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)**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 657 960 B1

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.

[0004] From JP07 240990A a hearing aid is known having plural microphones M1, M2, and M3. The energy contents in each of the microphone signals from the microphones M1, M2 and M3 is determined, and the microphone signal with the lowest energy contents is selected.

[0005] In prior art document JP 0724991 A, an adaptive microphone is provided, wherein 3 microphones M1, M2 and a directional microphone M3 are provided. An adaptive calculation algorithm calculates a directional signal from microphone input signals derived from microphones M1 and M2. The energy content of the calculated directional signal and the energy content of the signal derived from M3 are calculated and compared and the signal with the lowest energy content is selected as the output signal.

SUMMARY OF THE INVENTION

[0006] 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.

[0007] 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 affected 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.

[0008] 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

[0009] Fig. 1 shows the device to detect the ultrasound according to the invention

DESCRIPTION OF A PREFERRED EMBODIMENT

[0010] 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.

[0011] 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 saturation 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.

[0012] When a microphone 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.

[0013] 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.

[0014] 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 in the following way: - detect if the energy in one of the microphones is above a given limit, - compare the energy from two channels,
and if the energy in the channel with highest energy is a given number of times larger than the energy in the other channel it is determined that at least one of the microphones is subjected to an ultrasound sound-field, and a corresponding status value is routed to a digital signal processing unit resulting in that the signal from the microphone signal with the lowest content of energy is routed through the signal processing device to an output unit.

2. Listening device with two or more microphones comprising means for carrying out the steps of the method for detecting and minimizing the harmful influence of ultra sound in a listening device according to claim 1.

Patentansprüche

1. Verfahren zum Erfassen und Minimieren des schadhaften Einflusses von Ultraschall in einem Hörgerät mit zwei oder mehr Mikrophonen, wobei die Energiegehalte in den Mikrophonsignalen folgendermaßen bestimmt und wobei die zeitbezogenen Änderungen der Energiegehalte der Mikrophonsignale folgendermaßen analysiert werden:

- Erfassen, ob die Energie in einem der Mikrophone über einem vorgegebenen Wert liegt,
- Vergleichen der Energie von zwei Kanälen,

und falls die Energie in dem Kanal mit höchster Energie um ein vorgegebenes Vielfaches größer als die Energie des anderen Kanals ist, wird festgelegt, dass wenigstens eines der Mikrophone einem Ultraschall Schallfeld ausgesetzt ist, und ein entsprechender Statuswert wird zu einer digitalen Signalverarbeitungseinheit gesendet, welches zur Folge hat, dass das Signal des Mikrophonsignals mit der geringsten Energiemenge durch die Signalverarbeitungseinheit zu einer Ausgabeeinheit geleitet wird.

2. Hörgerät mit zwei oder mehr Mikrophonen, das Mittel zum Ausführen der Schritte des Verfahrens zum Erfassen und Minimieren des schadhaften Einflusses von Ultraschall in einem Hörgerät nach Anspruch 1 aufweist.

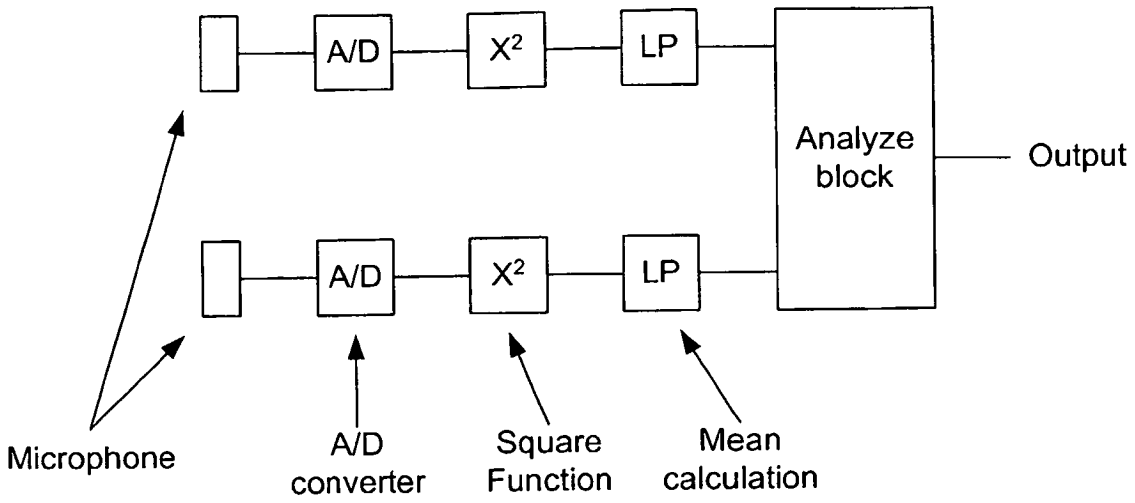
Revendications

1. Méthode de détection et de minimisation de l'influence néfaste d'ultrasons dans un dispositif d'écoute pourvu de deux ou plusieurs microphones, selon laquelle le contenu d'énergie dans les signaux de microphone est déterminé, et selon laquelle les variations liées au temps du contenu d'énergie des signaux de microphone sont analysés de la manière suivante :

- détecter si l'énergie dans l'un des microphones est supérieure à une limite donnée,
- comparer l'énergie à partir de deux canaux,

et si l'énergie dans le canal avec la plus haute énergie est un nombre donné de fois plus grande que l'énergie dans l'autre canal, il est déterminé qu'au moins l'un des microphones est soumis à un champ acoustique ultrasonore, et une valeur d'état correspondante est acheminée à une unité de traitement de signal numérique ayant pour résultat que le signal du signal de microphone dont le contenu d'énergie est plus faible est acheminé à travers le dispositif de traitement de signal jusqu'à une unité de sortie.

2. Dispositif d'écoute avec deux microphones ou plus comprenant des moyens pour mettre en oeuvre les étapes de la méthode de détection et de minimisation de l'influence néfaste d'ultra-sons dans un dispositif d'écoute selon la revendication 1.


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

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 7240990 A **[0004]**
- JP 0724991 A **[0005]**