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Doc description: Information Disclosure Statement (IDS) Filed

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)	Application Number	
	Filing Date	2019-01-14
	First Named Inventor	Steven Wayne Goldstein
	Art Unit	
	Examiner Name	
	Attorney Docket Number	11472-39-2_PRS-130US2

U.S.PATENTS							Remove
Examiner Initial*	Cite No	Patent Number	Kind Code ¹	Issue Date	Name of Patentee or Applicant of cited Document	Pages, Columns, Lines where Relevant Passages or Relevant Figures Appear	
	1	4809262		1989-02-28	Klose et al.		
	2	5259033		1993-11-02	Goodings et al.		
	3	5999828		1999-12-07	Sih et al.		
	4	6304648		2001-10-16	Chang		
	5	6381572		2002-04-30	Ishimitsu et al.		
	6	6647368		2003-11-11	Nemirovski		
	7	6754359		2004-06-22	Svean et al.		
	8	6870807		2005-03-22	Chan et al.		

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	9	7236580		2007-06-26	Sarkar et al.	
	10	7783054		2010-08-24	Ringlstetter et al.	
	11	7986802		2011-07-26	Ziller	
	12	8060366		2011-11-15	Maganti et al.	
	13	8275145		2012-09-25	Buck et al.	
	14	8380521		2013-02-19	Maganti et al.	
	15	8401178		2013-03-19	Chen et al.	
	16	8838184		2014-09-16	Burnett et al.	
	17	7039195		2006-05-02	Svean et al.	
	18	8081780		2011-12-20	Goldstein et al.	
	19	6728385		2004-04-27	Kvalo	

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	20	6738482		2004-05-18	Jaber	
	21	6081732		2000-06-27	Suwanen et al.	
	22	6169912		2001-01-02	Zuckerman	
	23	6570985		2003-05-27	Romesburg	
	24	7349353		2008-03-25	Guduru et al.	
	25	6131032		1992-07-14	Esaki et al.	
	26	6760453		2004-07-06	Banno	
	27	6963901		1999-10-05	Vanatalo et al.	
	28	6021207		2000-02-01	Puthuff	
	29	6692059		1997-11-25	Kruger	
	30	6118878		2000-09-12	Jones	

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	31	6631196		2003-10-07	Taenzer et al.	
	32	7817803		2010-10-19	Goldstein	
	33	8027481		2011-09-27	Beard	
	34	5796819		1998-08-18	Romesburg	
	35	7403608		2008-07-22	Auvray et al.	
	36	7003097		2006-02-21	Marchok et al.	
	37	6466666		2002-10-15	Eriksson	

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	1	20080037801		2008-02-14	Alves et al.	
	2	20010046304		2001-11-29	Rast	

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	3	20030112947		2003-06-19	Cohen	
	4	20040137969		2004-07-15	Nassimi	
	5	20050102133		2005-05-12	Rees	
	6	20060062395		2006-03-23	Klayman et al.	
	7	20070291953		2007-12-20	Ngia et al.	
	8	20080019539		2008-01-24	Patel et al.	
	9	20090147966		2009-06-11	McIntosh et al.	
	10	20120184337		2012-07-19	Burnett et al.	
	11	20130051543		2013-02-28	McDysan et al.	
	12	20140370838		2014-12-18	Kim	
	13	20150288823		2015-10-08	Burnett et al.	

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	14	20090010444		2009-01-08	Goldstein et al.	
	15	20050058313		2005-03-17	Victorian et al.	
	16	20050069161		2005-03-31	Kaltenbach et al.	
	17	20070189544		2007-06-16	Rosenberg	
	18	20040202340		2004-10-14	Armstrong et al.	
	19	20090034748		2009-02-05	Sibbald	
	20	20070036342		2007-02-15	Boillot et al.	
	21	20060067512		2006-03-30	Boillot et al.	

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FOREIGN PATENT DOCUMENTS

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¹ See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. ² Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). ³ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁴ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁵ Applicant is to place a check mark here if English language translation is attached.			

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CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Peter A. Chiabotti/	Date (YYYY-MM-DD)	2019-01-14
Name/Print	Peter A. Chiabotti	Registration Number	54603

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1 hour to complete, including gathering, preparing and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:



Practitioners associated with the Customer Number:

150139

OR



Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:



The address associated with Customer Number:

150139

OR

Firm or
Individual Name

Address

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State

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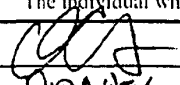
Assignee Name and Address:

Staton Techiya LLC. 16193 Bridlewood Circle, Delray Beach, FL 33445

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	8-14-17
Name	DANIEL C - STARIN	Telephone	513-404-0099
Title	MANAGING MEMBER		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: Staton Techiya, LLC

Application No./Patent No.: _____ Filed/Issue Date: January 14, 2019

Titled: METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION

Staton Techiya, LLC, a limited liability company

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is ____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

- A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
- B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: John Usher To: Personics Holdings, Inc.

The document was recorded in the United States Patent and Trademark Office at
Reel 047282, Frame 0609, or for which a copy thereof is attached.

2. From: Marc Andre Boillot To: Personics Holdings, Inc.

The document was recorded in the United States Patent and Trademark Office at
Reel 046937, Frame 0919, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: Steve Wayne Goldstein To: Personics Holdings, Inc.

The document was recorded in the United States Patent and Trademark Office at
Reel 047213, Frame 0047, or for which a copy thereof is attached.

4. From: Jason McIntosh To: Personics Holdings, Inc.

The document was recorded in the United States Patent and Trademark Office at
Reel 046937, Frame 0484, or for which a copy thereof is attached.

5. From: Personics Holdings, Inc., Personics Holdings, LLC To: DM Staton Family Limited Partnership

The document was recorded in the United States Patent and Trademark Office at
Reel 047509, Frame 0264, or for which a copy thereof is attached.

6. From: DM Staton Family Limited Partnership To: Staton Techiya, LLC

The document was recorded in the United States Patent and Trademark Office at
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☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/Peter A. Chiabotti/

January 14, 2019

Signature

Date

Peter A. Chiabotti

54,603

Printed or Typed Name

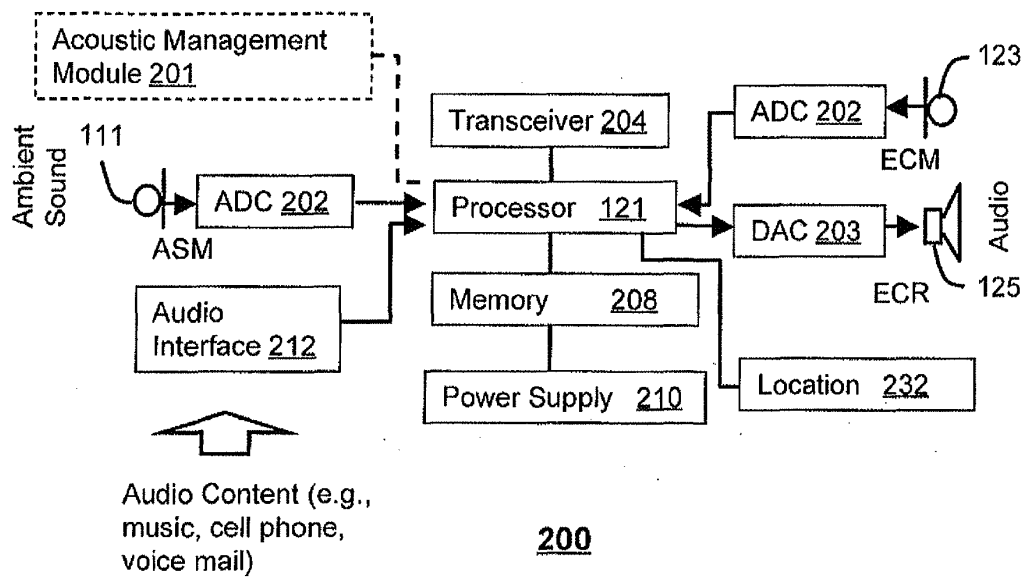
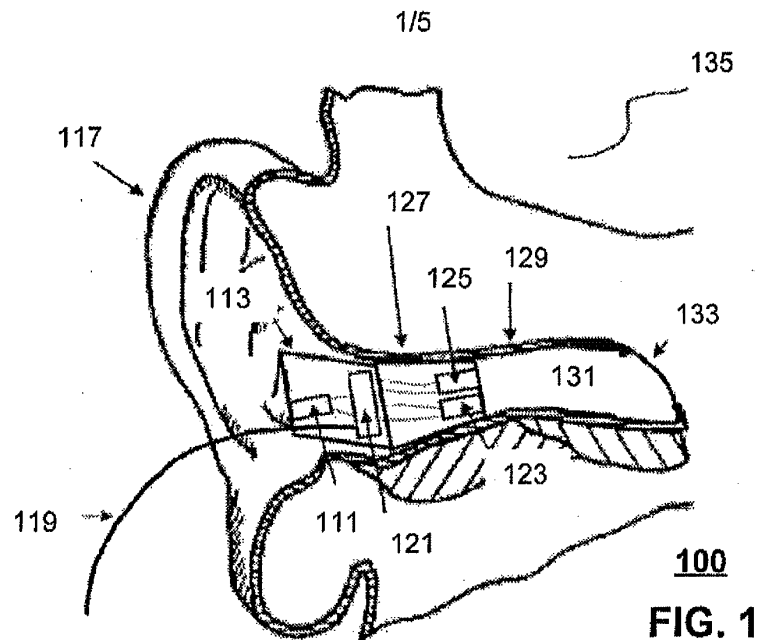
Title or Registration Number

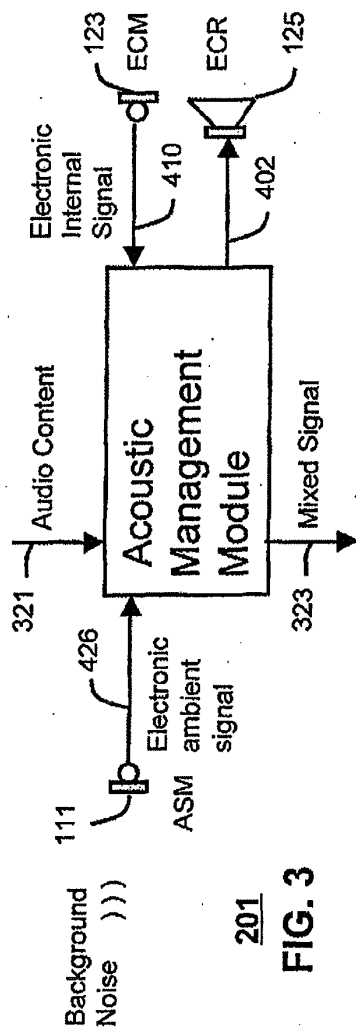
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2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.





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FIG. 3

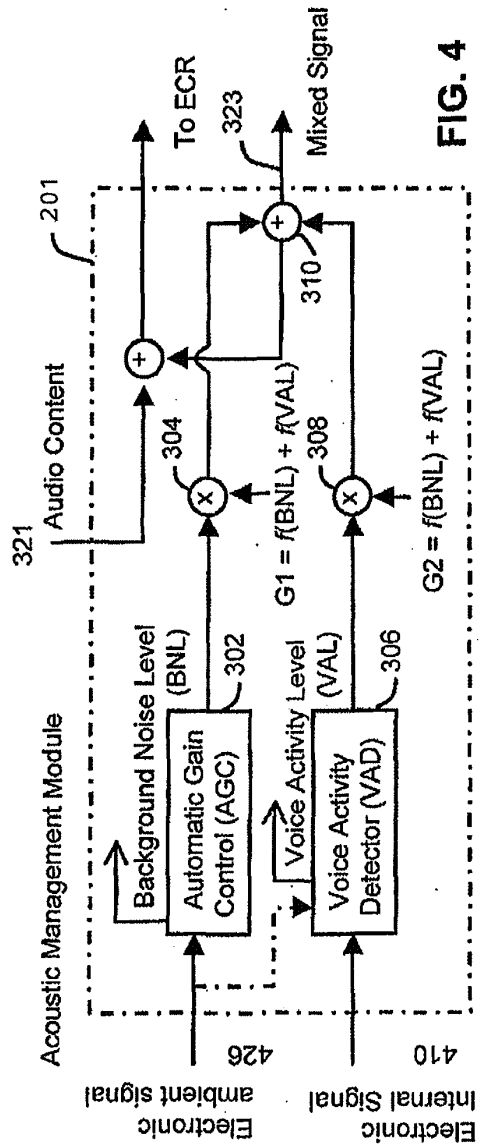


FIG. 4

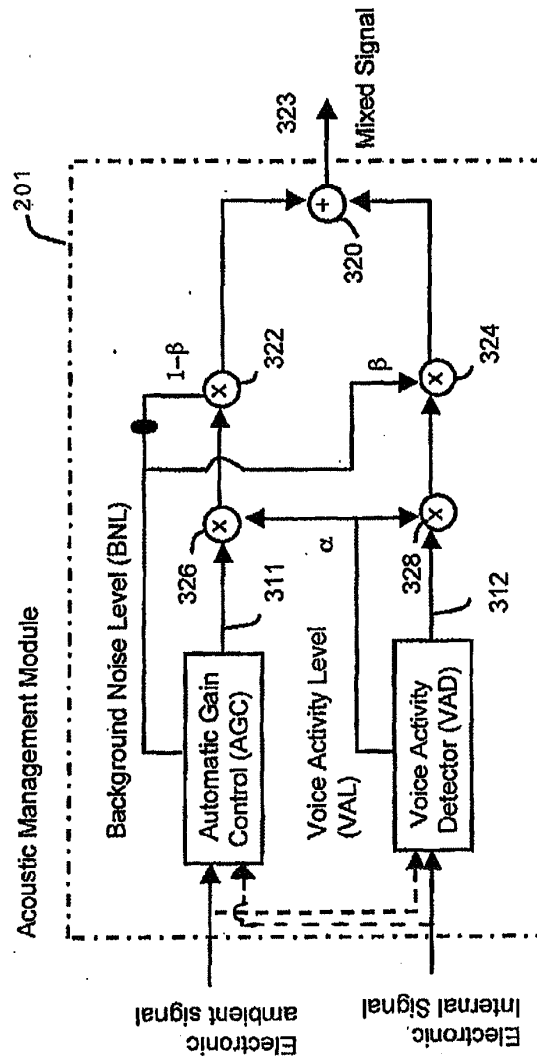
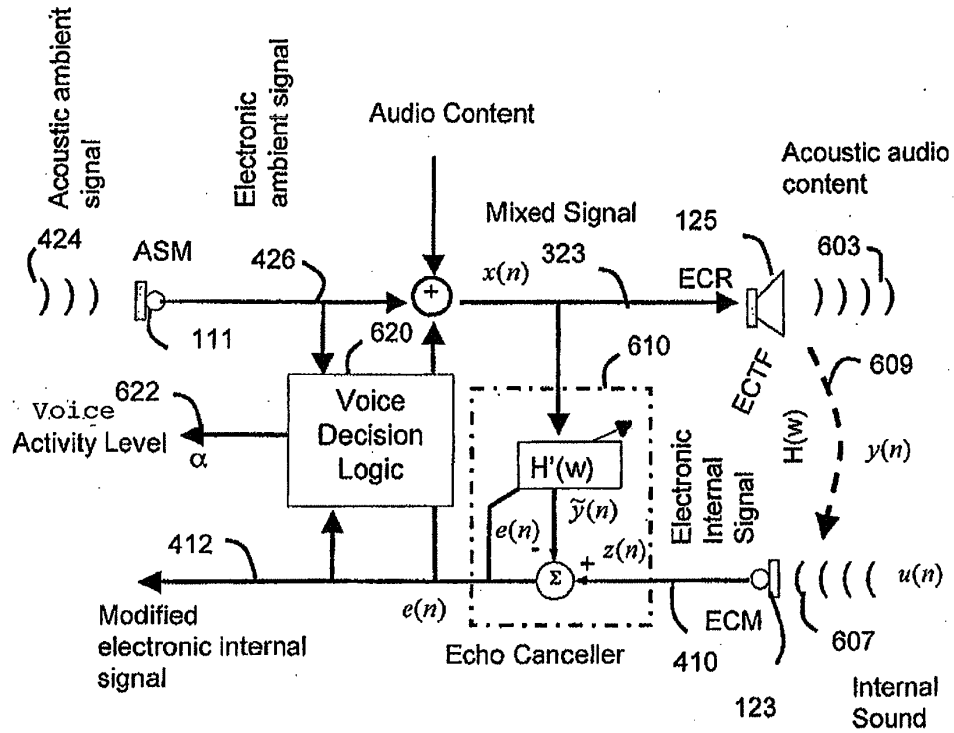


FIG. 5



600

FIG. 6

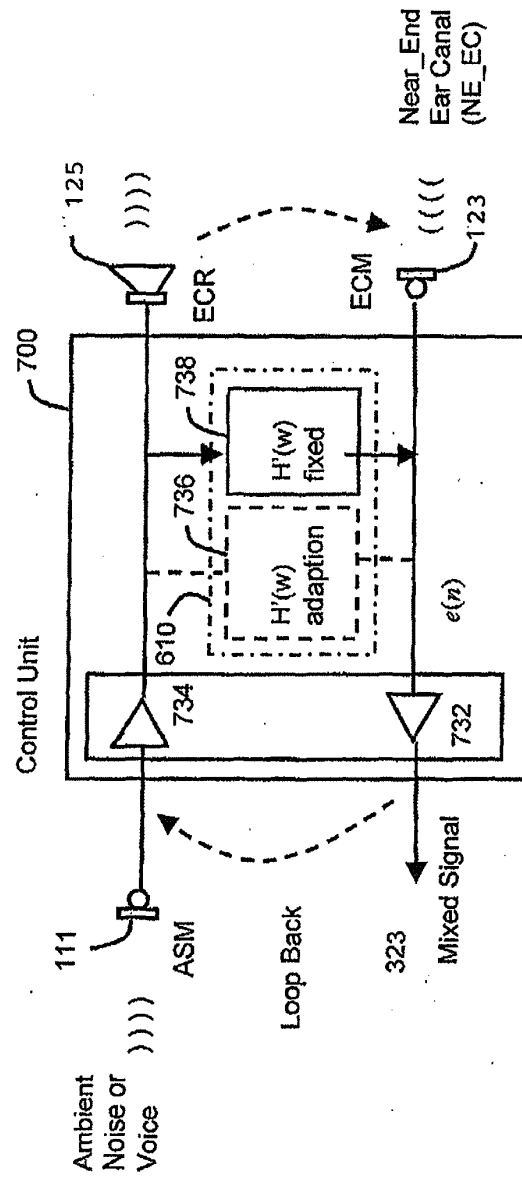


FIG. 7

METHOD AND APPARATUS FOR IN-EAR CANAL ECHO SUPPRESSION

CROSS-REFERENCE TO RELATED APPLICATION(S)

[0001] This application is a Continuation of U.S. Patent Application Serial No. 13/956,767, filed on August 1, 2018, which is a Continuation of U.S. Patent Application Serial No. 12/170,171, filed on July 9, 2008, now U.S. Patent No. 8,526,645, which is a Continuation-In-Part of U.S. Patent Application Serial No. 12/115,349, filed on May 5, 2008, now U.S. Patent No. 8,081,780, which claims the priority benefit of U.S. Provisional Application Serial No. 60/916,271, filed on May 4, 2007, the entire disclosures of which are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention pertains to sound reproduction, sound recording, audio communications and hearing protection using earphone devices designed to provide variable acoustical isolation from ambient sounds while being able to audition both environmental and desired audio stimuli. Particularly, the present invention describes a method and device for suppressing echo in an ear-canal when capturing a user's voice when using an ambient sound microphone and an ear canal microphone.

BACKGROUND OF THE INVENTION

[0003] People use headsets or earpieces primarily for voice communications and music listening enjoyment. A headset or earpiece generally includes a microphone and a speaker for allowing the user to speak and listen. An ambient sound microphone mounted on the earpiece can capture ambient sounds in the environment; sounds that can include the user's voice. An ear canal microphone mounted internally on the earpiece can capture voice resonant within the ear canal; sounds generated when the user is speaking.

[0004] An earpiece that provides sufficient occlusion can utilize both the ambient sound microphone and the ear canal microphone to enhance the user's voice. An ear canal receiver

mounted internal to the ear canal can loopback sound captured at the ambient sound microphone or the ear canal microphone to allow the user to listen to captured sound. If the earpiece is however not properly sealed within the ear canal, the ambient sounds can leak through into the ear canal and create an echo feedback condition with the ear canal microphone and ear canal receiver. In such cases, the feedback loop can generate an annoying "howling" sound that degrades the quality of the voice communication and listening experience.

SUMMARY OF THE INVENTION

[0005] Embodiments in accordance with the present invention provide a method and device for in-ear canal echo suppression.

[0006] In a first embodiment, a method for in-ear canal echo suppression control can include the steps of capturing an ambient acoustic signal from at least one Ambient Sound Microphone (ASM) to produce an electronic ambient signal, capturing in an ear canal an internal sound from at least one Ear Canal Microphone (ECM) to produce an electronic internal signal, measuring a background noise signal from the electronic ambient signal and the electronic internal signal, and capturing in the ear canal an internal sound from an Ear Canal Microphone (ECM) to produce an electronic internal signal. The electronic internal signal includes an echo of a spoken voice generated by a wearer of the earpiece. The echo in the electronic internal signal can be suppressed to produce a modified electronic internal signal containing primarily the spoken voice. A voice activity level can be generated for the spoken voice based on characteristics of the modified electronic internal signal and a level of the background noise signal. The electronic ambient signal and the electronic internal signal can then be mixed in a ratio dependent on the background noise signal to produce a mixed signal without echo that is delivered to the ear canal by way of the ECR.

[0007] An internal gain of the electronic internal signal can be increased as background noise levels increase, while an external gain of the electronic ambient signal can be decreased as the background noise levels increase. Similarly, the internal gain of the electronic internal signal can be increased as background noise levels decrease, while an external gain of the electronic

ambient signal can be increased as the background noise levels decrease. The step of mixing can include filtering the electronic ambient signal and the electronic internal signal based on a characteristic of the background noise signal. The characteristic can be a level of the background noise level, a spectral profile, or an envelope fluctuation.

[0008] At low background noise levels and low voice activity levels, the electronic ambient signal can be amplified relative to the electronic internal signal in producing the mixed signal. At medium background noise levels and voice activity levels, low frequencies in the electronic ambient signal and high frequencies in the electronic internal signal can be attenuated. At high background noise levels and high voice activity levels, the electronic internal signal can be amplified relative to the electronic ambient signal in producing the mixed signal.

[0009] The method can include adapting a first set of filter coefficients of a Least Mean Squares (LMS) filter to model an inner ear-canal microphone transfer function (ECTF). The voice activity level of the modified electronic internal signal can be monitored, and an adaptation of the first set of filter coefficients for the modified electronic internal signal can be frozen if the voice activity level is above a predetermined threshold. The voice activity level can be determined by an energy level characteristic and a frequency response characteristic. A second set of filter coefficients for a replica of the LMS filter can be generated during the freezing, and substituted back for the first set of filter coefficients when the voice activity level is below another predetermined threshold. The modified electronic internal signal can be transmitted to another voice communication device, and looped back to the ear canal.

[0010] In a second embodiment, a method for in-ear canal echo suppression control can include capturing an ambient sound from at least one Ambient Sound Microphone (ASM) to produce an electronic ambient signal, delivering audio content to an ear canal by way of an Ear Canal Receiver (ECR) to produce an acoustic audio content, capturing in the ear canal by way of an Ear Canal Receiver (ECR) the acoustic audio content to produce an electronic internal signal, generating a voice activity level of a spoken voice in the presence of the acoustic audio content, suppressing an echo of the spoken voice in the electronic internal signal to produce a modified electronic internal signal, and controlling a mixing of the electronic ambient signal and the

electronic internal signal based on the voice activity level. At least one voice operation of the earpiece can be controlled based on the voice activity level. The modified electronic internal signal can be transmitted to another voice communication device and looped back to the ear canal.

[0011] The method can include measuring a background noise signal from the electronic ambient signal and the electronic internal signal, and mixing the electronic ambient signal with the electronic internal signal in a ratio dependent on the background noise signal to produce a mixed signal that is delivered to the ear canal by way of the ECR. An acoustic attenuation level of the earpiece and an audio content level reproduced can be accounted for when adjusting the mixing based on a level of the audio content, the background noise level, and an acoustic attenuation level of the earpiece. The electronic ambient signal and the electronic internal signal can be filtered based on a characteristic of the background noise signal. The characteristic can be a level of the background noise level, a spectral profile, or an envelope fluctuation. The method can include applying a first gain (G1) to the electronic ambient signal, and applying a second gain (G2) to the electronic internal signal. The first gain and second gain can be a function of the background noise level and the voice activity level.

[0012] The method can include adapting a first set of filter coefficients of a Least Mean Squares (LMS) filter to model an inner ear-canal microphone transfer function (ECTF). The adaptation of the first set of filter coefficients can be frozen for the modified electronic internal signal if the voice activity level is above a predetermined threshold. A second set of filter coefficients for a replica of the LMS filter can be adapted during the freezing. The second set can be substituted back for the first set of filter coefficients when the voice activity level is below another predetermined threshold. The adaptation of the first set of filter coefficients can then be unfrozen.

[0013] In a third embodiment, an earpiece to provide in-ear canal echo suppression can include an Ambient Sound Microphone (ASM) configured to capture ambient sound and produce an electronic ambient signal, an Ear Canal Receiver (ECR) to deliver audio content to an ear canal to produce an acoustic audio content, an Ear Canal Microphone (ECM) configured to capture

internal sound including spoken voice in an ear canal and produce an electronic internal signal, and a processor operatively coupled to the ASM, the ECM and the ECR. The audio content can be a phone call, a voice message, a music signal, or the spoken voice. The processor can be configured to suppress an echo of the spoken voice in the electronic internal signal to produce a modified electronic internal signal, generate a voice activity level for the spoken voice based on characteristics of the modified electronic internal signal and a level of the background noise signal, and mix the electronic ambient signal with the electronic internal signal in a ratio dependent on the background noise signal to produce a mixed signal that is delivered to the ear canal by way of the ECR. The processor can play the mixed signal back to the ECR for loopback listening. A transceiver operatively coupled to the processor can transmit the mixed signal to a second communication device.

[0014] A Least Mean Squares (LMS) echo suppressor can model an inner ear-canal microphone transfer function (ECTF) between the ASM and the ECM. A voice activity detector operatively coupled to the echo suppressor can adapt a first set of filter coefficients of the echo suppressor to model an inner ear-canal microphone transfer function (ECTF), and freeze an adaptation of the first set of filter coefficients for the modified electronic internal signal if the voice activity level is above a predetermined threshold. The voice activity detector during the freezing can also adapt a second set of filter coefficients for the echo suppressor, and substitute the second set of filter coefficients for the first set of filter coefficients when the voice activity level is below another predetermined threshold. Upon completing the substitution, the processor can unfreeze the adaptation of the first set of filter coefficients.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. 1 is a pictorial diagram of an earpiece in accordance with an exemplary embodiment;

[0016] FIG. 2 is a block diagram of the earpiece in accordance with an exemplary embodiment;

[0017] FIG. 3 is a block diagram for an acoustic management module in accordance with an exemplary embodiment;

[0018] FIG. 4 is a schematic for the acoustic management module of FIG. 3 illustrating a mixing of an external microphone signal with an internal microphone signal as a function of a background noise level and voice activity level in accordance with an exemplary embodiment;

[0019] FIG. 5 is a more detailed schematic of the acoustic management module of FIG. 3 illustrating a mixing of an external microphone signal with an internal microphone signal based on a background noise level and voice activity level in accordance with an exemplary embodiment;

[0020] FIG. 6 is a block diagram of a system for in-ear canal echo suppression in accordance with an exemplary embodiment; and

[0021] FIG. 7 is a schematic of a control unit for controlling adaptation of a first set and second set of filter coefficients of an echo suppressor for in-ear canal echo suppression in accordance with an exemplary embodiment.

DETAILED DESCRIPTION

[0022] The following description of at least one exemplary embodiment is merely illustrative in nature and is in no way intended to limit the invention, its application, or uses.

[0023] Processes, techniques, apparatus, and materials as known by one of ordinary skill in the relevant art may not be discussed in detail but are intended to be part of the enabling description where appropriate, for example the fabrication and use of transducers.

[0024] In all of the examples illustrated and discussed herein, any specific values, for example the sound pressure level change, should be interpreted to be illustrative only and non-limiting. Thus, other examples of the exemplary embodiments could have different values.

[0025] Note that similar reference numerals and letters refer to similar items in the following figures, and thus once an item is defined in one figure, it may not be discussed for following figures.

[0026] Note that herein when referring to correcting or preventing an error or damage (e.g., hearing damage), a reduction of the damage or error and/or a correction of the damage or error are intended.

[0027] Various embodiments herein provide a method and device for automatically mixing audio signals produced by a pair of microphone signals that monitor a first ambient sound field and a second ear canal sound field, to create a third new mixed signal. An Ambient Sound Microphone (ASM) and an Ear Canal Microphone (ECM) can be housed in an earpiece that forms a seal in the ear of a user. The third mixed signal can be auditioned by the user with an Ear Canal Receiver (ECR) mounted in the earpiece, which creates a sound pressure in the occluded ear canal of the user. A voice activity detector can determine when the user is speaking and control an echo suppressor to suppress associated feedback in the ECR.

[0028] When the user engages in a voice communication, the echo suppressor can suppress feedback of the spoken voice from the ECR. The echo suppressor can contain two sets of filter coefficients; a first set that adapts when voice is not present and becomes fixed when voice is present, and a second set that adapts when the first set is fixed. The voice activity detector can discriminate between audible content, such as music, that the user is listening to, and spoken voice generated by the user when engaged in voice communication. The third mixed signal contains primarily the spoken voice captured at the ASM and ECM without echo, and can be transmitted to a remote voice communications system, such as a mobile phone, personal media player, recording device, walkie-talkie radio, etc. Before the ASM and ECM signals are mixed, they can be echo suppressed and subjected to different filters and at optional additional gains. This permits a single earpiece to provide full-duplex voice communication with proper or improper acoustic sealing.

[0029] The characteristic responses of the ASM and ECM filter can differ based on characteristics of the background noise and the voice activity level. In some exemplary embodiments, the filter response can depend on the measured Background Noise Level (BNL). A gain of a filtered ASM and a filtered ECM signal can also depend on the BNL. The (BNL) can be calculated using either or both the conditioned ASM and/or ECM signal(s). The BNL can be a slow time weighted average of the level of the ASM and/or ECM signals, and can be weighted using a frequency-weighting system, e.g. to give an A-weighted SPL level (i.e. the high and low frequencies are attenuated before the level of the microphone signals are calculated).

[0030] At least one exemplary embodiment of the invention is directed to an earpiece for voice operated control. Reference is made to FIG. 1 in which an earpiece device, generally indicated as earpiece 100, is constructed and operates in accordance with at least one exemplary embodiment of the invention. As illustrated, earpiece 100 depicts an electro-acoustical assembly 113 for an in-the-ear acoustic assembly, as it would typically be placed in the ear canal 131 of a user 135. The earpiece 100 can be an in the ear earpiece, behind the ear earpiece, receiver in the ear, open-fit device, or any other suitable earpiece type. The earpiece 100 can be partially or fully occluded in the ear canal, and is suitable for use with users having healthy or abnormal auditory functioning.

[0031] Earpiece 100 includes an Ambient Sound Microphone (ASM) 111 to capture ambient sound, an Ear Canal Receiver (ECR) 125 to deliver audio to an ear canal 131, and an Ear Canal Microphone (ECM) 123 to assess a sound exposure level within the ear canal 131. The earpiece 100 can partially or fully occlude the ear canal 131 to provide various degrees of acoustic isolation. The assembly is designed to be inserted into the user's ear canal 131, and to form an acoustic seal with the walls 129 of the ear canal at a location 127 between the entrance 117 to the ear canal and the tympanic membrane (or ear drum) 133. Such a seal is typically achieved by means of a soft and compliant housing of assembly 113. Such a seal creates a closed cavity 131 of approximately 5 cc between the in-ear assembly 113 and the tympanic membrane 133. As a result of this seal, the ECR (speaker) 125 is able to generate a full range frequency response when reproducing sounds for the user. This seal also serves to significantly reduce the sound pressure level at the user's eardrum resulting from the sound field at the entrance to the ear canal

131. This seal is also a basis for a sound isolating performance of the electro-acoustic assembly.

[0032] Located adjacent to the ECR 125, is the ECM 123, which is acoustically coupled to the (closed or partially closed) ear canal cavity 131. One of its functions is that of measuring the sound pressure level in the ear canal cavity 131 as a part of testing the hearing acuity of the user as well as confirming the integrity of the acoustic seal and the working condition of the earpiece 100. In one arrangement, the ASM 111 can be housed in the assembly 113 to monitor sound pressure at the entrance to the occluded or partially occluded ear canal. All transducers shown can receive or transmit audio signals to a processor 121 that undertakes audio signal processing and provides a transceiver for audio via the wired or wireless communication path 119.

[0033] The earpiece 100 can actively monitor a sound pressure level both inside and outside an ear canal and enhance spatial and timbral sound quality while maintaining supervision to ensure safe sound reproduction levels. The earpiece 100 in various embodiments can conduct listening tests, filter sounds in the environment, monitor warning sounds in the environment, present notification based on identified warning sounds, maintain constant audio content to ambient sound levels, and filter sound in accordance with a Personalized Hearing Level (PHL).

[0034] The earpiece 100 can measure ambient sounds in the environment received at the ASM 111. Ambient sounds correspond to sounds within the environment such as the sound of traffic noise, street noise, conversation babble, or any other acoustic sound. Ambient sounds can also correspond to industrial sounds present in an industrial setting, such as, factory noise, lifting vehicles, automobiles, and robots to name a few.

[0035] The earpiece 100 can generate an Ear Canal Transfer Function (ECTF) to model the ear canal 131 using ECR 125 and ECM 123, as well as an Outer Ear Canal Transfer function (OETF) using ASM 111. For instance, the ECR 125 can deliver an impulse within the ear canal and generate the ECTF via cross correlation of the impulse with the impulse response of the ear canal. The earpiece 100 can also determine a sealing profile with the user's ear to compensate for any leakage. It also includes a Sound Pressure Level Dosimeter to estimate sound exposure and recovery times. This permits the earpiece 100 to safely administer and monitor sound exposure

to the ear.

[0036] Referring to FIG. 2, a block diagram 200 of the earpiece 100 in accordance with an exemplary embodiment is shown. As illustrated, the earpiece 100 can include the processor 121 operatively coupled to the ASM 111, ECR 125, and ECM 123 via one or more Analog to Digital Converters (ADC) 202 and Digital to Analog Converters (DAC) 203. The processor 121 can utilize computing technologies such as a microprocessor, Application Specific Integrated Chip (ASIC), and/or digital signal processor (DSP) with associated storage memory 208 such as Flash, ROM, RAM, SRAM, DRAM or other like technologies for controlling operations of the earpiece device 100. The processor 121 can also include a clock to record a time stamp.

[0037] As illustrated, the earpiece 100 can include an acoustic management module 201 to mix sounds captured at the ASM 111 and ECM 123 to produce a mixed sound. The processor 121 can then provide the mixed signal to one or more subsystems, such as a voice recognition system, a voice dictation system, a voice recorder, or any other voice related processor or communication device. The acoustic management module 201 can be a hardware component implemented by discrete or analog electronic components or a software component. In one arrangement, the functionality of the acoustic management module 201 can be provided by way of software, such as program code, assembly language, or machine language.

[0038] The memory 208 can also store program instructions for execution on the processor 121 as well as captured audio processing data and filter coefficient data. The memory 208 can be off-chip and external to the processor 121, and include a data buffer to temporarily capture the ambient sound and the internal sound, and a storage memory to save from the data buffer the recent portion of the history in a compressed format responsive to a directive by the processor 121. The data buffer can be a circular buffer that temporarily stores audio sound at a current time point to a previous time point. It should also be noted that the data buffer can in one configuration reside on the processor 121 to provide high speed data access. The storage memory can be non-volatile memory such as SRAM to store captured or compressed audio data.

[0039] The earpiece 100 can include an audio interface 212 operatively coupled to the processor

121 and acoustic management module 201 to receive audio content, for example from a media player, cell phone, or any other communication device, and deliver the audio content to the processor 121. The processor 121 responsive to detecting spoken voice from the acoustic management module 201 can adjust the audio content delivered to the ear canal. For instance, the processor 121 (or acoustic management module 201) can lower a volume of the audio content responsive to detecting a spoken voice. The processor 121 by way of the ECM 123 can also actively monitor the sound exposure level inside the ear canal and adjust the audio to within a safe and subjectively optimized listening level range based on voice operating decisions made by the acoustic management module 201.

[0040] The earpiece 100 can further include a transceiver 204 that can support singly or in combination any number of wireless access technologies including without limitation Bluetooth.TM., Wireless Fidelity (WiFi), Worldwide Interoperability for Microwave Access (WiMAX), and/or other short or long range communication protocols. The transceiver 204 can also provide support for dynamic downloading over-the-air to the earpiece 100. It should be noted also that next generation access technologies can also be applied to the present disclosure.

[0041] The location receiver 232 can utilize common technology such as a common GPS (Global Positioning System) receiver that can intercept satellite signals and therefrom determine a location fix of the earpiece 100.

[0042] The power supply 210 can utilize common power management technologies such as replaceable batteries, supply regulation technologies, and charging system technologies for supplying energy to the components of the earpiece 100 and to facilitate portable applications. A motor (not shown) can be a single supply motor driver coupled to the power supply 210 to improve sensory input via haptic vibration. As an example, the processor 121 can direct the motor to vibrate responsive to an action, such as a detection of a warning sound or an incoming voice call.

[0043] The earpiece 100 can further represent a single operational device or a family of devices configured in a master-slave arrangement, for example, a mobile device and an earpiece. In the

latter embodiment, the components of the earpiece 100 can be reused in different form factors for the master and slave devices.

[0044] FIG. 3 is a block diagram of the acoustic management module 201 in accordance with an exemplary embodiment. Briefly, the Acoustic management module 201 facilitates monitoring, recording and transmission of user-generated voice (speech) to a voice communication system. User-generated sound is detected with the ASM 111 that monitors a sound field near the entrance to a user's ear, and with the ECM 123 that monitors a sound field in the user's occluded ear canal. A new mixed signal 323 is created by filtering and mixing the ASM and ECM microphone signals. The filtering and mixing process is automatically controlled depending on the background noise level of the ambient sound field to enhance intelligibility of the new mixed signal 323. For instance, when the background noise level is high, the acoustic management module 201 automatically increases the level of the ECM 123 signal relative to the level of the ASM 111 to create the new signal mixed 323. When the background noise level is low, the acoustic management module 201 automatically decreases the level of the ECM 123 signal relative to the level of the ASM 111 to create the new signal mixed 323

[0045] As illustrated, the ASM 111 is configured to capture ambient sound and produce an electronic ambient signal 426, the ECM 123 is configured to pass, process, or play acoustic audio content 402 (e.g., audio content 321, mixed signal 323) to the ear canal, and the ECM 123 is configured to capture internal sound in the ear canal and produce an electronic internal signal 410. The acoustic management module 201 is configured to measure a background noise signal from the electronic ambient signal 426 or the electronic internal signal 410, and mix the electronic ambient signal 426 with the electronic internal signal 410 in a ratio dependent on the background noise signal to produce the mixed signal 323. The acoustic management module 201 filters the electronic ambient signal 426 and the electronic internal 410 signal based on a characteristic of the background noise signal using filter coefficients stored in memory or filter coefficients generated algorithmically.

[0046] In practice, the acoustic management module 201 mixes sounds captured at the ASM 111 and the ECM 123 to produce the mixed signal 323 based on characteristics of the background

noise in the environment and a voice activity level. The characteristics can be a background noise level, a spectral profile, or an envelope fluctuation. The acoustic management module 201 manages echo feedback conditions affecting the voice activity level when the ASM 111, the ECM 123, and the ECR 125 are used together in a single earpiece for full-duplex communication, when the user is speaking to generate spoken voice (captured by the ASM 111 and ECM 123) and simultaneously listening to audio content (delivered by ECR 125).

[0047] In noisy ambient environments, the voice captured at the ASM 111 includes the background noise from the environment, whereas, the internal voice created in the ear canal 131 captured by the ECM 123 has less noise artifacts, since the noise is blocked due to the occlusion of the earpiece 100 in the ear. It should be noted that the background noise can enter the ear canal if the earpiece 100 is not completely sealed. In this case, when speaking, the user's voice can leak through and cause an echo feedback condition that the acoustic management module 201 mitigates.

[0048] FIG. 4 is a schematic of the acoustic management module 201 illustrating a mixing of the electronic ambient signal 426 with the electronic internal signal 410 as a function of a background noise level (BNL) and a voice activity level (VAL) in accordance with an exemplary embodiment. As illustrated, the acoustic management module 201 includes an Automatic Gain Control (AGC) 302 to measure background noise characteristics. The acoustic management module 201 also includes a Voice Activity Detector (VAD) 306. The VAD 306 can analyze either or both the electronic ambient signal 426 and the electronic internal signal 410 to estimate the VAL. As an example, the VAL can be a numeric range such as 0 to 10 indicating a degree of voicing. For instance, a voiced signal can be predominately periodic due to the periodic vibrations of the vocal cords. A highly voiced signal (e.g., vowel) can be associated with a high level, and a non-voiced signal (e.g., fricative, plosive, consonant) can be associated with a lower level.

[0049] The acoustic management module 201 includes a first gain (G1) 304 applied to the AGC processed electronic ambient signal 426. A second gain (G2) 308 is applied to the VAD processed electronic internal signal 410. The acoustic management module 201 applies the first

gain (G1) 304 and the second gain (G2) 308 as a function of the background noise level and the voice activity level to produce the mixed signal 323, where

$$G1=f(BNL)+f(VAL) \text{ and } G2=f(BNL)+f(VAL)$$

[0050] As illustrated, the mixed signal 323 is the sum 310 of the G1 scaled electronic ambient signal and the G2 scaled electronic internal signal. The mixed signal 323 can then be transmitted to a second communication device (e.g. second cell phone, voice recorder, etc.) to receive the enhanced voice signal. The acoustic management module 201 can also play the mixed signal 323 back to the ECR for loopback listening. The loopback allows the user to hear himself or herself when speaking, as though the earpiece 100 and associated occlusion effect were absent. The loopback can also be mixed with the audio content 321 based on the background noise level, the VAL, and audio content level. The acoustic management module 201 can also account for an acoustic attenuation level of the earpiece, and account for the audio content level reproduced by the ECR when measuring background noise characteristics. Echo conditions created as a result of the loopback can be mitigated to ensure that the voice activity level is accurate.

[0051] FIG. 5 is a more detailed schematic of the acoustic management module 201 illustrating a mixing of an external microphone signal with an internal microphone signal based on a background noise level and voice activity level in accordance with an exemplary embodiment. In particular, the gain blocks for G1 and G2 of FIG. 4 are a function of the BNL and the VAL and are shown in greater detail. As illustrated, the AGC produces a BNL that can be used to set a first gain 322 for the processed electronic ambient signal 311 and a second gain 324 for the processed electronic internal signal 312. For instance, when the BNL is low (<70 dBA), gain 322 is set higher relative to gain 324 so as to amplify the electronic ambient signal 311 in greater proportion than the electronic internal signal 312. When the BNL is high (>85 dBA), gain 322 is set lower relative to gain 324 so as to attenuate the electronic ambient signal 311 in greater proportion than the electronic internal signal 312. The mixing can be performed in accordance with the relation:

$$\text{Mixed signal}=(1-\text{.beta.})\text{electronic ambient signal}+(\text{.beta.})\text{*electronic internal signal}$$

where $(1-\beta)$ is an external gain, β is an internal gain, and the mixing is performed with $0 < \beta < 1$.

[0052] As illustrated, the VAD produces a VAL that can be used to set a third gain 326 for the processed electronic ambient signal 311 and a fourth gain 328 for the processed electronic internal signal 312. For instance, when the VAL is low (e.g., 0-3), gain 326 and gain 328 are set low so as to attenuate the electronic ambient signal 311 and the electronic internal signal 312 when spoken voice is not detected. When the VAL is high (e.g., 7-10), gain 326 and gain 328 are set high so as to amplify the electronic ambient signal 311 and the electronic internal signal 312 when spoken voice is detected.

[0053] The gain scaled processed electronic ambient signal 311 and the gain scaled processed electronic internal signal 312 are then summed at adder 320 to produce the mixed signal 323. The mixed signal 323, as indicated previously, can be transmitted to another communication device, or as loopback to allow the user to hear his or her self.

[0054] FIG. 6 is an exemplary schematic of an operational unit 600 of the acoustic management module for in-ear canal echo suppression in accordance with an embodiment. The operational unit 600 may contain more or less than the number of components shown in the schematic. The operational unit 600 can include an echo suppressor 610 and a voice decision logic 620.

[0055] The echo suppressor 610 can be a Least Mean Squares (LMS) or Normalized Least Mean Squares (NLMS) adaptive filter that models an ear canal transfer function (ECTF) between the ECR 125 and the ECM 123. The echo suppressor 610 generates the modified electronic signal, $e(n)$, which is provided as an input to the voice decision logic 620; $e(n)$ is also termed the error signal $e(n)$ of the echo suppressor 610. Briefly, the error signal $e(n)$ 412 is used to update the filter $H(w)$ to model the ECTF of the echo path. The error signal $e(n)$ 412 closely approximates the user's spoken voice signal $u(n)$ 607 when the echo suppressor 610 accurately models the ECTF.

[0056] In the configuration shown the echo suppressor 610 minimizes the error between the filtered signal, $\{\tilde{\gamma}\}(n)$, and the electronic internal signal, $z(n)$, in an effort to obtain a transfer function H' which is a best approximation to the $H(w)$ (i.e., ECTF). $H(w)$ represents the transfer function of the ear canal and models the echo response. $z(n)=u(n)+y(n)+v(n)$, where $u(n)$ is the spoken voice 607, $y(n)$ is the echo 609, and $v(n)$ is background noise (if present, for instance due to improper sealing.)

[0057] During operation, the echo suppressor 610 monitors the mixed signal 323 delivered to the ECR 125 and produces an echo estimate $y(n)$ of an echo $y(n)$ 609 based on the captured electronic internal signal 410 and the mixed signal 323. The echo suppressor 610, upon learning the ECTF by an adaptive process, can then suppress the echo $y(n)$ 609 of the acoustic audio content 603 (e.g., output mixed signal 323) in the electronic internal signal $z(n)$ 410. It subtracts the echo estimate $y(n)$ from the electronic internal signal 410 to produce the modified electronic internal signal $e(n)$ 412.

[0058] The voice decision logic 620 analyzes the modified electronic signal 412 $e(n)$ and the electronic ambient signal 426 to produce a voice activity level 622, α . The voice activity level α identifies a probability that the user is speaking, for example, when the user is using the earpiece for two way voice communication. The voice activity level 622 can also indicate a degree of voicing (e.g., periodicity, amplitude). When the user is speaking, voice is captured externally (such as from acoustic ambient signal 424) by the ASM 111 in the ambient environment and also by the ECM 123 in the ear canal. The voice decision logic provides the voice activity level α to the acoustic management module 201 as an input parameter for mixing the ASM 111 and ECM 123 signals. Briefly referring back to FIG. 4, the acoustic management module 201 performs the mixing as a function of the voice activity level α and the background noise level (see $G=f(BNL)+f(VAL)$).

[0059] For instance, at low background noise levels and low voice activity levels, the acoustic management module 201 amplifies the electronic ambient signal 426 from the ASM 111 relative to the electronic internal signal 410 from the ECM 123 in producing the mixed signal 323. At medium background noise levels and medium voice activity levels, the acoustic management

module 201 attenuates low frequencies in the electronic ambient signal 426 and attenuates high frequencies in the electronic internal signal 410. At high background noise levels and high voice activity levels, the acoustic management module 201 amplifies the electronic internal signal 410 from the ECM 123 relative to the electronic ambient signal 426 from the ASM 111 in producing the mixed signal. The acoustic management module 201 can additionally apply frequency specific filters based on the characteristics of the background noise.

[0060] FIG. 7 is a schematic of a control unit 700 for controlling adaptation of a first set (736) and a second set (738) of filter coefficients of the echo suppressor 610 for in-ear canal echo suppression in accordance with an exemplary embodiment. Briefly, the control unit 700 illustrates a freezing (fixing) of weights upon detection of spoken voice. The echo suppressor resumes weight adaptation when $e(n)$ is low, and freezes weights when $e(n)$ is high signifying a presence of spoken voice.

[0061] When the user is not speaking, the ECR 125 can pass through ambient sound captured at the ASM 111, thereby allowing the user to hear environmental ambient sounds. As previously discussed, the echo suppressor 610 models an ECTF and suppresses an echo of the mixed signal 323 that is looped back to the ECR 125 by way of the ASM 111 (see dotted line Loop Back path). When the user is not speaking, the echo suppressor continually adapts to model the ECTF. When the ECTF is properly modeled, the echo suppressor 610 produces a modified internal electronic signal $e(n)$ that is low in amplitude level (i.e., low in error). The echo suppressor adapts the weights to keep the error signal low. When the user speaks, the echo suppressor however initially produces a high-level $e(n)$ (e.g., the error signal increases). This happens since the speaker's voice is uncorrelated with the audio signal played out the ECR 125, which disrupts the echo suppressor's ECTF modeling ability.

[0062] The control unit 700 upon detecting a rise in $e(n)$, freezes the weights of the echo suppressor 610 to produce a fixed filter $H'(w)$ fixed 738. Upon detecting the rise in $e(n)$ the control unit adjusts the gain 734 for the ASM signal and the gain 732 for the mixed signal 323 that is looped back to the ECR 125. The mixed signal 323 fed back to the ECR 125 permits the user to hear themselves speak. Although the weights are frozen when the user is speaking, a

second filter $H'(w)$ 736 continually adapts the weights for generating a second $e(n)$ that is used to determine a presence of spoken voice. That is, the control unit 700 monitors the second error signal $e(n)$ produced by the second filter 736 for monitoring a presence of the spoken voice.

[0063] The first error signal $e(n)$ (in a parallel path) generated by the first filter 738 is used as the mixed signal 323. The first error signal contains primarily the spoken voice since the ECTF model has been fixed due to the weights. That is, the second (adaptive) filter is used to monitor a presence of spoken voice, and the first (fixed) filter is used to generate the mixed signal 323.

[0064] Upon detecting a fall of $e(n)$, the control unit restores the gains 734 and 732 and unfreezes the weights of the echo suppressor, and the first filter $H'(w)$ returns to being an adaptive filter. The second filter $H'(w)$ 736 remains on stand-by until spoken voice is detected, and at which point, the first filter $H'(w)$ 738 goes fixed, and the second filter $H'(w)$ 736 begins adaptation for producing the $e(n)$ signal that is monitored for voice activity. Notably, the control unit 700 monitors $e(n)$ from the first filter 738 or the second filter 736 for changes in amplitude to determine when spoken voice is detected based on the state of voice activity.

[0065] Where applicable, the present embodiments of the invention can be realized in hardware, software or a combination of hardware and software. Any kind of computer system or other apparatus adapted for carrying out the methods described herein are suitable. A typical combination of hardware and software can be a mobile communications device with a computer program that, when being loaded and executed, can control the mobile communications device such that it carries out the methods described herein. Portions of the present method and system may also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein and which when loaded in a computer system, is able to carry out these methods.

[0066] While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all modifications, equivalent structures and functions of the relevant exemplary

embodiments. Thus, the description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the exemplary embodiments of the present invention. Such variations are not to be regarded as a departure from the spirit and scope of the present invention.

CLAIMS

We claim:

1. A method, comprising:
 - producing an electronic internal signal based on an internal sound captured by an ear canal microphone, wherein the electronic internal signal includes a voice generated by a wearer of an earpiece;
 - determining a voice activity level for the voice based on the electronic internal signal;
 - mixing an electronic ambient signal with the electronic internal signal in a ratio dependent on the voice activity level and a background noise signal to produce a mixed signal;
 - suppressing an echo of the voice by subtracting an echo estimate from the electronic internal signal to produce a modified electronic internal signal; and
 - freezing an adaptation of a first set of filter coefficients for the modified electronic internal signal when the voice activity level is above a first threshold.
2. The method of claim 1, further comprising generating the echo estimate based on the electronic internal signal and the mixed signal.
3. The method of claim 1, further comprising adapting, during the freezing, a second set of filter coefficients for the modified electronic internal signal when the voice activity level is below a second threshold that is different from the first threshold.
4. The method of claim 3, further comprising unfreezing the adaptation after substituting the second set of filter coefficients for the first set of filter coefficients.
5. The method of claim 1, further comprising obtaining the background noise signal from the electronic ambient signal, the electronic internal signal, or a combination thereof.
6. The method of claim 1, further comprising identifying a probability that the wearer is speaking based on the voice activity level.

7. The method of claim 1, further comprising indicating, by utilizing the voice activity level, a degree of voicing, wherein the degree of voicing corresponds to a periodicity, an amplitude, or a combination thereof.
8. The method of claim 1, further comprising amplifying the electronic ambient signal when a background noise level and the voice activity level are at a low level.
9. The method of claim 1, further comprising attenuating a low frequency in the electronic ambient signal and attenuating a high frequency in the electronic internal signal when a background noise level and the voice activity level are at a medium level.
10. The method of claim 1, further comprising amplifying the electronic internal signal relative to the electronic ambient signal when a background noise level and the voice activity level are at a high level.
11. The method of claim 1, further comprising increasing an internal gain of the electronic internal signal as a background noise level decreases and further comprising increasing an external gain of the electronic ambient signal as the background noise level decreases.
12. The method of claim 1, further comprising increasing an internal gain of the electronic internal signal as a background noise level increases, and further comprising decreasing an external gain of the electronic ambient signal as the background noise level increases.
13. The method of claim 1, further comprising determining the voice activity level based on an energy level characteristic and a frequency response characteristic.
14. A system, comprising:
 - a processor that performs operations, comprising:
 - generating an electronic internal signal based on an internal sound captured by an ear canal microphone, wherein the electronic internal signal includes a voice generated

- by a wearer of an earpiece;
- determining a voice activity level for the voice based on the electronic internal signal;
- mixing an electronic ambient signal with the electronic internal signal in a ratio dependent on the voice activity level and a background noise signal to produce a mixed signal;
- suppressing an echo of the voice by subtracting an echo estimate from the electronic internal signal to produce a modified electronic internal signal; and
- freezing an adaptation of a first set of filter coefficients for the modified electronic internal signal when the voice activity level is above a first threshold.
15. The system of claim 14, wherein the operations further comprise modeling an inner ear-canal microphone transfer function between an ambient sound microphone and the ear canal microphone.
16. The system of claim 14, wherein the operations further comprise playing the mixed signal to an ear canal receiver for loopback listening.
17. The system of claim 14, wherein the operations further comprise adapting, during the freezing, a second set of filter coefficients for the modified electronic internal signal when the voice activity level is below a second threshold that is different from the first threshold.
18. The system of claim 17, wherein the operations further comprise unfreezing the adaptation after substituting the second set of filter coefficients for the first set of filter coefficients.
19. The system of claim 14, wherein the operations further comprise utilizing an ear canal receiver to pass through the electronic ambient signal when the voice activity level indicates that the wearer is not speaking.
20. An earpiece, comprising:

an ear canal microphone; and

a processor that operation comprising:

generating an electronic internal signal based on an internal sound captured by the ear canal microphone, wherein the electronic internal signal includes a voice generated by a wearer of the earpiece;

mixing an electronic ambient signal with the electronic internal signal in a ratio dependent on a voice activity level and a background noise signal to produce a mixed signal;

suppressing an echo of the voice by subtracting an echo estimate from the electronic internal signal to produce a modified electronic internal signal; and

freezing an adaptation of a first set of filter coefficients for the modified electronic internal signal when the voice activity level is above a first threshold.

ABSTRACT

An earpiece (100) and acoustic management module (300) for in-ear canal echo suppression control suitable is provided. The earpiece can include an Ambient Sound Microphone (111) to capture ambient sound, an Ear Canal Receiver (125) to deliver audio content to an ear canal, an Ear Canal Microphone (123) configured to capture internal sound, and a processor (121) to generate a voice activity level (622) and suppress an echo of spoken voice in the electronic internal signal, and mix an electronic ambient signal with an electronic internal signal in a ratio dependent on the voice activity level and a background noise level to produce a mixed signal (323) that is delivered to the ear canal (131).

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		
First Named Inventor/Applicant Name:		Steven Wayne Goldstein		
Filer:		Peter Allen Chiabotti/Angela Martin		
Attorney Docket Number:		11472-39-3_PRS-130US3		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				785

Electronic Acknowledgement Receipt	
EFS ID:	34846197
Application Number:	16247186
International Application Number:	
Confirmation Number:	3901
Title of Invention:	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION
First Named Inventor/Applicant Name:	Steven Wayne Goldstein
Customer Number:	150139
Filer:	Peter Allen Chiabotti/Angela Martin
Filer Authorized By:	Peter Allen Chiabotti
Attorney Docket Number:	11472-39-3_PR-130US3
Receipt Date:	14-JAN-2019
Filing Date:	
Time Stamp:	17:05:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$785
RAM confirmation Number	011519INTEFSW00003708500951
Deposit Account	500951
Authorized User	Angela Martin
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)					
37 CFR 1.20 (Post Issuance fees)					
37 CFR 1.21 (Miscellaneous fees and charges)					
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	WebADS.pdf	158479	no	9
			0c3e323de591a6564952652fe012d498407a6be3		
Warnings:					
Information:					
2		11472-39-3_Declarations-Executed.PDF	359803	yes	4
			81f6b4e0a51c48aeee4bb0972b4342d8a18b7bde		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Oath or Declaration filed		1	1	
	Oath or Declaration filed		2	2	
	Oath or Declaration filed		3	3	
	Oath or Declaration filed		4	4	
Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	11472-39-3_IDS.PDF	1036007	no	9
			8d31098cd1806b6b3c168145d4e67bf55b6cba53		
Warnings:					
Information:					
4	Power of Attorney	11472-39-3_POA-Executed.PDF	68755	no	1
			f58120e904276d6eba18a5c4a5aa2ce720df5f06		
Warnings:					
Information:					

5	Assignee showing of ownership per 37 CFR 3.73	11472-39-3_CFR_Statement.PDF	123915	no	3
			06d99fb8c34a43d791c1a469b1171eea7d4f0946		
Warnings:					
Information:					
6	Drawings-other than black and white line drawings	11472-39-3_Drawings.PDF	102794	no	5
			501833a3e95fa974d46593655ca917a2b29efcfd		
Warnings:					
Information:					
7		11472-39-3_Patent_Application.PDF	297052	yes	24
			9fae728071e0b84437871aac97237f02e15a67d		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	19	
	Claims		20	23	
	Abstract		24	24	
Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	35201	no	2
			84c7e7c8b1920ac545f15e825ef641478963207b		
Warnings:					
Information:					
Total Files Size (in bytes):			2182006		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Steven	Wayne	Goldstein		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Delray Beach	State/Province	FL	Country of Residence ⁱ	US
Mailing Address of Inventor:					
Address 1		16193 Bridlewood Circle			
Address 2					
City	Delray Beach	State/Province	FL		
Postal Code	33445	Country ⁱ	US		
Inventor 2					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Marc	Andre	Boillot		
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	Plantation	State/Province	FL	Country of Residence ⁱ	US
Mailing Address of Inventor:					
Address 1		16193 Bridlewood Circle			
Address 2					
City	Delray Beach	State/Province	FL		
Postal Code	33445	Country ⁱ	US		
Inventor 3					
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	John		Usher		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service			
City	Devon	Country of Residence ⁱ	GB

Mailing Address of Inventor:

Address 1	16193 Bridlewood Circle		
Address 2			
City	Delray Beach	State/Province	FL
Postal Code	33445	Country ⁱ	US

Inventor 4**Legal Name**

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jason		McIntosh	

Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service

City	Sugar Hill	State/Province	GA	Country of Residence ⁱ	US
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Mailing Address of Inventor:

Address 1	16193 Bridlewood Circle		
Address 2			
City	Delray Beach	State/Province	FL
Postal Code	33445	Country ⁱ	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button.

Add

Correspondence Information:Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).☐ An Address is being provided for the correspondence information of this application.

Customer Number	150139
Email Address	ip@akerman.com

Add Email

Remove Email

Application Information:

Title of the Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		
Attorney Docket Number	11472-39-3_PRS-130US3	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	Suggested Figure for Publication (if any)	6

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:					
☒ Customer Number		☐ US Patent Practitioner		☐ Limited Recognition (37 CFR 11.9)	
Customer Number		30448			
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Prefix	Given Name	Middle Name	Family Name	Suffix	Remove
Registration Number					
Additional Representative Information blocks may be generated within this form by selecting the Add button.					

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status		Pending		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
		13956767	2013-08-01		
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13956767	Continuation of	12170171	2008-07-09	8526645	2013-09-03
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
12170171	Continuation in part of	12115349	2008-05-05	8081780	2011-12-20
Prior Application Status		Expired		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12115349	Claims benefit of provisional	60916271	2007-05-04		
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.					

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ¹	Filing Date (YYYY-MM-DD)	Access Code ¹ (if applicable)
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. ☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant 1			
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
			Clear
☒ Assignee	☐ Legal Representative under 35 U.S.C. 117	☐ Joint Inventor	
☐ Person to whom the inventor is obligated to assign.		☐ Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor:			
If the Applicant is an Organization check here. ☒			
Organization Name	Staton Techiya, LLC		
Mailing Address Information For Applicant:			
Address 1	16193 Bridlewood Circle		
Address 2			
City	Delray Beach	State/Province	FL
Country ¹	US	Postal Code	33445
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Assignee 1			
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.			
If the Assignee or Non-Applicant Assignee is an Organization check here. ☒			
Organization Name	Staton Techiya, LLC		
Mailing Address Information For Assignee including Non-Applicant Assignee:			
Address 1	16193 Bridlewood Circle		
Address 2			
City	Delray Beach	State/Province	FL
Country i	US	Postal Code	33445
Phone Number		Fax Number	
Email Address			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.			

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	11472-39-3_PRS-130US3
		Application Number	
Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION		

Signature:

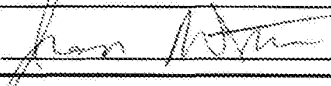
NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Peter A. Chiabotti/			Date (YYYY-MM-DD)	
First Name	Peter A.	Last Name	Chiabotti	Registration Number	54603
Additional Signature may be generated within this form by selecting the Add button.					

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION
As the below named inventor, I hereby declare that: This declaration is directed to: ☐ The attached application, or ☒ United States application or PCT international application number <u>13/956,767</u> filed on <u>August 1, 2013</u> The above-identified application was made or authorized to be made by me. I believe that I am the original inventor or an original joint inventor of a claimed invention in the application. I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both. WARNING: Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.	
LEGAL NAME OF INVENTOR Inventor: <u>Jason McIntosh</u> Date (Optional): <u>11-15-2018</u> Signature: <u></u>	
Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.	

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	METHOD AND DEVICE FOR IN EAR CANAL ECHO SUPPRESSION
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This declaration is directed to: ☐ The attached application, or ☒ United States application or PCT international application number 13/956,767
filed on August 1, 2013.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

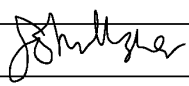
I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

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LEGAL NAME OF INVENTOR

Inventor: John Usher Date (Optional) : _____

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR

Inventor: Steven Wayne Goldstein Date (Optional) : _____

Signature: Steve Goldstein

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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LEGAL NAME OF INVENTOR	
Inventor: <u>Marc Andre Boillot</u> Date (Optional): <u>11/12/18</u> Signature: 	
Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.	

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Application Number: 16247186

Document Date: 01/14/2019

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