

AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of Texas - Waco Division on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.);

DOCKET NO. 6:22-cv-575	DATE FILED 6/3/2022	U.S. DISTRICT COURT Western District of Texas - Waco Division
PLAINTIFF EIGHT KHZ, LLC		DEFENDANT META PLATFORMS, INC.; META PLATFORMS TECHNOLOGIES, LLC
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 9,282,196	3/8/2016	Glen A. Norris; Philip Scott Lyren
2 9,674,628	6/6/2017	Glen A. Norris; Philip Scott Lyren
3 10,448,184	10/15/2019	Philip Scott Lyren; Glen A. Norris
4 10,917,737	2/9/2021	Philip Scott Lyren; Glen A. Norris
5 9,226,090	12/29/2015	Glen A. Norris; Philip Scott Lyren

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT		
CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy

AO 120 (Rev. 08/10)

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DOCKET NO.	DATE FILED 6/3/2022	U.S. DISTRICT COURT Western District of Texas - Waco Division
PLAINTIFF EIGHT KHZ, LLC		DEFENDANT META PLATFORMS, INC.; META PLATFORMS TECHNOLOGIES, LLC
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,368,179	7/30/2019	Philip Scott Lyren; Glen A. Norris
2 10,798,509	10/6/2020	Philip Scott Lyren; Glen A. Norris
3 11,172,316	11/9/2021	Philip Scott Lyren; Glen A. Norris
4 11,290,836	3/24/2020	Glen A. Norris; Philip Scott Lyren
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT		
CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	02/09/2021	10917737	PSL-037 (CON 4)	1238

64021 7590 01/20/2021
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

C Matter Limited, Wadsworth, OH;
Philip Scott Lyren, Bangkok, THAILAND;
Glen A. Norris, Tokyo, JAPAN;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

IR103 (Rev. 10/09)

Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

☐ Claims renumbered in the same order as presented by applicant
 ☐ CPA
 ☒ T.D.
 ☐ R.1.47

CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28		37	6	46		55	17	64
	2		11		20		29		38	7	47		56	18	65
	3		12		21		30		39	8	48		57	19	66
	4		13		22		31		40	9	49		58	20	67
	5		14		23		32	1	41	10	50		59		
	6		15		24		33	2	42	11	51		60		
	7		16		25		34	3	43	12	52	14	61		
	8		17		26		35	4	44	13	53	15	62		
	9		18		27		36	5	45		54	16	63		

Change(s) applied
 to document,
 /K.S.S./
 1/8/2021

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
AKELAW TESHALE/ Primary Examiner, Art Unit 2653	29 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20201229

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Philip Lyren, et al.	Examiner:	Akelaw Teshale
Serial No.:	16/558,088	Group Art Unit:	2653
Filed:	31 August 2019	Docket No.:	PSL-037 (CON 4)
Title:	Defining a Zone with a HPED and Providing Binaural Sound in the zone		

Payment Issue Fee

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

On 12/10/2020, the USPTO mailed a Notice of Allowance, and Applicant paid the issue fee on this date. On 12/30/2020, the USPTO mailed a second Notice of Allowability. Applicant files this issue fee transmittal in response to this second notice of Allowability.

No fees are due since Applicant already paid the issue fee on 12/10/2020.

The Commissioner is authorized to charge any fees due to deposit account 40-3766.

Respectfully submitted,

/Philip S. Lyren #40,709/

Philip S. Lyren
Reg. No. 40,709
Ph: 216-539-0572

Electronic Acknowledgement Receipt	
EFS ID:	41601988
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	DEFINING A ZONE WITH A HPED AND PROVIDING BINAURAL SOUND IN THE ZONE
First Named Inventor/Applicant Name:	Philip Scott Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	10-JAN-2021
Filing Date:	31-AUG-2019
Time Stamp:	00:08:53
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Issue_Fee.pdf	147565	no	1
			1c0f78eb37595ed720205c97ce73a589e0494d4b		
Warnings:					

Information:					
2	Miscellaneous Incoming Letter	Misc_Letter.pdf	17874	no	1
			d20a536c491c9fac6c53bb647c423a40edexdb69		
Warnings:					
Information:					
Total Files Size (in bytes):			165439		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

64021 7590 12/10/2020
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)	1238

TITLE OF INVENTION: ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(\$) DUE	DATE DUE
nonprovisional	SMALL	\$600	\$0.00	\$0.00	\$600	03/10/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
TESHALE, AKELAW	2653	381-303000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

- ☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)
- ☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 40-3766

5. Change in Entity Status (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Philip Lyren/

Date 9 January 2021

Typed or printed name Philip Lyren

Registration No. 40709



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)	1238
64021	7590	12/30/2020	EXAMINER	
PHILIP S. LYREN, PC 289 Woodland Avenue Wadsworth, OH 44281			TESHALE, AKELAW	
			ART UNIT	PAPER NUMBER
			2653	
			MAIL DATE	DELIVERY MODE
			12/30/2020	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of Allowability	Application No. 16/558,088	Applicant(s) Lyren et al.	
	Examiner AKELAW A TESHALE	Art Unit 2653	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 12/21/2020.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 41-53 and 61-67. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)	5. ☐ Examiner's Amendment/Comment
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.	6. ☒ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.	7. ☐ Other _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____.	

/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	
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DETAILED ACTION

Reasons for Allowance

1. **Claims 41-53 and 61-67** are allowed.
2. The following is an examiner's statement of reasons for allowance: Applicant arguments/ Remarks filed on 09/14/2020 in conjunction with the remarks pages 8-10 has been reviewed by the examiner in view of the prior art of record and it is agreed that the prior art of record does not teach the independent claims 41,48 and 61.

Claims 42-47 are allowed as depending from claim 41.

Claims 49-53 are allowed as depending from claim 48.

Claims 62-67 are allowed as depending from claim 61.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AKELAW A TESHLE whose telephone number is (571)270-5302. The examiner can normally be reached on 9 am -6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fan Tsang can be reached on (571)272-7547. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AKELAW TESHLE
Primary Examiner
Art Unit 2653

/AKELAW TESHLE/
Primary Examiner, Art Unit 2653

Notice of References Cited	Application/Control No. 16/558,088		Applicant(s)/Patent Under Reexamination Lyren et al.	
	Examiner AKELAW A TESHAE		Art Unit 2653	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20130163765-A1	06-2013	De Jong; Janice Leigh	H04S7/304	381/17
*	B	US-9271080-B2	02-2016	Mahabub; Jerry	H04R5/00	1/1
*	C	US-20150373477-A1	12-2015	Norris; Glen A.	H04M1/605	381/303
*	D	US-20120213375-A1	08-2012	Mahabub; Jerry	H04S5/00	381/17
*	E	US-9584946-B1	02-2017	Lyren; Philip Scott	H04M1/0202	1/1
*	F	US-5982903-A	11-1999	Kinoshita; Ikuichiro	H04S1/005	381/17
*	G	US-9584653-B1	02-2017	Lyren; Philip Scott	H04S7/304	1/1
*	H	US-5715317-A	02-1998	Nakazawa; Masayuki	H04S1/007	381/17
*	I	US-20080144794-A1	06-2008	Gardner; William G.	H04M3/568	379/202.01
*	J	US-20160227338-A1	08-2016	OH; Hyunoh	H04S7/303	1/1
*	K	US-5438623-A	08-1995	Begault; Durand R.	H04S1/005	381/17
*	L	US-20030044002-A1	03-2003	Yeager, David M.	H04S7/302	379/444
*	M	US-20120183161-A1	07-2012	Agevik; Markus	H04S7/302	381/303

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)

Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20201229

<i>Search Notes</i> 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHAE	Art Unit 2653

CPC - Searched*		
Symbol	Date	Examiner
H04S7/304, H04S7/303, H04R5/033, H04S3/008, H04S2400/01, H04S2420/01, H04S2400/11, H04S2420/01, H04S2400/11, H04S7/ 304, H04S7/303, H04S1/007, H04S2400/01, H04S7/305, H04S3/008 , H04S2400/15, H04S7/302, H04S1/002, H04S1/005, H04S7/30, H04S7/40, H04S2400/13, H04S7/301, H04S7/306, H04S2420/00, H04S5/00, H04S7/308	12/07/2020	AT

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor name search (east)	12/07/2020	AT
east search (US-PGPUB;USPAT;USOCR;FPRS;EPO;JPO; DERWENT;IBM_TDB)	12/07/2020	AT
Please see east search attachment	12/08/2020	AT

/AKELAW TESHAE/ Primary Examiner, Art Unit 2653	
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<i>Search Notes</i> 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
east interference search		12/07/2020	AT

/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	
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Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

CPC						
Symbol					Type	Version
H04S	/	7	/	304	F	2013-01-01
H04S	/	7	/	303	I	2013-01-01
H04R	/	5	/	033	I	2013-01-01
H04S	/	3	/	008	I	2013-01-01
H04S	/	2420	/	01	A	2013-01-01
H04S	/	2400	/	11	A	2013-01-01
H04S	/	2400	/	01	A	2013-01-01

CPC Combination Sets					
Symbol		Type	Set	Ranking	Version
	/		/		

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	29 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20201229

Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

INTERNATIONAL CLASSIFICATION		
CLAIMED		
H04S	7	00
NON-CLAIMED		

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	29 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20201229

Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHLE	Art Unit 2653

☐ Claims renumbered in the same order as presented by applicant
 ☐ CPA
 ☒ T.D.
 ☐ R.1.47

CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19		28		37	6	46		55	17	64
	2		11		20		29		38	7	47		56	18	65
	3		12		21		30		39	8	48		57	19	66
	4		13		22		31		40	9	49		58	20	67
	5		14		23		32	1	41	10	50		59		
	6		15		24		33	2	42	11	51		60		
	7		16		25		34	3	43	12	52	14	61		
	8		17		26		35	4	44	13	53	14	62		
	9		18		27		36	5	45		54	16	63		

NONE	Total Claims Allowed:	
(Assistant Examiner)	(Date)	20
/AKELAW TESHLE/ Primary Examiner, Art Unit 2653	29 December 2020	O.G. Print Claim(s) O.G. Print Figure
(Primary Examiner)	(Date)	1 1

U.S. Patent and Trademark Office

Part of Paper No.: 20201229



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO.	TOT CLAIMS	IND CLAIMS
16/558,088	08/31/2019	2653	985	PSL-037 (CON 4)	20	3

CONFIRMATION NO. 1238
CORRECTED FILING RECEIPT



CC000000122161813

64021
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

Date Mailed: 12/21/2020

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Philip Scott Lyren, Bangkok, THAILAND;
Glen A. Norris, Tokyo, JAPAN;

Applicant(s)

C Matter Limited, Wadsworth, OH;

Power of Attorney: The patent practitioners associated with Customer Number 64021

Domestic Priority data as claimed by applicant

This application is a CON of 15/635,166 06/27/2017 PAT 10587981
which is a CON of 15/429,131 02/09/2017 PAT 9699583
which is a CON of 15/365,880 11/30/2016 PAT 9800990
which claims benefit of 62/348,164 06/10/2016

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 09/11/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/558,088**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

DEFINING A ZONE WITH A HPED AND PROVIDING BINAURAL SOUND IN THE ZONE

Preliminary Class

381

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

page 2 of 4

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

64021 7590 12/10/2020
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

EXAMINER

TESHALE, AKELAW

ART UNIT

PAPER NUMBER

2653

DATE MAILED: 12/10/2020

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)	1238

TITLE OF INVENTION: ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$600	\$0.00	\$0.00	\$600	03/10/2021

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

64021 7590 12/10/2020
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)	1238

TITLE OF INVENTION: ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(\$) DUE	DATE DUE
nonprovisional	SMALL	\$600	\$0.00	\$0.00	\$600	03/10/2021

EXAMINER	ART UNIT	CLASS-SUBCLASS
TESHALE, AKELAW	2653	381-303000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

- ☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
- ☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

- (1) The names of up to 3 registered patent attorneys or agents OR, alternatively, 1 _____
- (2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2 _____
- 3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

- ☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)
- ☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

- ☐ Applicant certifying micro entity status. See 37 CFR 1.29
- ☐ Applicant asserting small entity status. See 37 CFR 1.27
- ☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)	1238
64021	7590	12/10/2020	EXAMINER	
PHILIP S. LYREN, PC			TESHALE, AKELAW	
289 Woodland Avenue			ART UNIT	
Wadsworth, OH 44281			PAPER NUMBER	

2653

DATE MAILED: 12/10/2020

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. 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 30 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, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. 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.

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 disclosure of these records is required by the Freedom of Information Act.
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 inspection 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.

Notice of Allowability	Application No. 16/558,088	Applicant(s) Lyren et al.	
	Examiner AKELAW A TESHALE	Art Unit 2653	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 09/14/2020.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 41-52 and 61-66. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
Certified copies:
a) ☐ All b) ☐ Some *c) ☐ None of the:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).
* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892)	5. ☐ Examiner's Amendment/Comment
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.	6. ☒ Examiner's Statement of Reasons for Allowance
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.	7. ☐ Other _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.	

/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	
---	--

DETAILED ACTION

Reasons for Allowance

1. **Claims 41-53 and 61-67** are allowed.
2. The following is an examiner's statement of reasons for allowance: Applicant arguments/ Remarks filed on 09/14/2020 in conjunction with the remarks pages 8-10 has been reviewed by the examiner in view of the prior art of record and it is agreed that the prior art of record does not teach the independent claims 41,48 and 61.

Claims 42-47 are allowed as depending from claim 41.

Claims 49-52 are allowed as depending from claim 48.

Claims 62-66 are allowed as depending from claim 61.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to AKELAW A TESHLE whose telephone number is (571)270-5302. The examiner can normally be reached on 9 am -6pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fan Tsang can be reached on (571)272-7547. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AKELAW TESHAE
Primary Examiner
Art Unit 2653

/AKELAW TESHAE/
Primary Examiner, Art Unit 2653

Notice of References Cited	Application/Control No. 16/558,088		Applicant(s)/Patent Under Reexamination Lyren et al.	
	Examiner AKELAW A TESHAE		Art Unit 2653	Page 1 of 2

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20130163765-A1	06-2013	De Jong; Janice Leigh	H04S7/304	381/17
*	B	US-9271080-B2	02-2016	Mahabub; Jerry	H04R5/00	1/1
*	C	US-20150373477-A1	12-2015	Norris; Glen A.	H04M1/605	381/303
*	D	US-20120213375-A1	08-2012	Mahabub; Jerry	H04S5/00	381/17
*	E	US-9584946-B1	02-2017	Lyren; Philip Scott	H04M1/0202	1/1
*	F	US-5982903-A	11-1999	Kinoshita; Ikuichiro	H04S1/005	381/17
*	G	US-9584653-B1	02-2017	Lyren; Philip Scott	H04S7/304	1/1
*	H	US-5715317-A	02-1998	Nakazawa; Masayuki	H04S1/007	381/17
*	I	US-20080144794-A1	06-2008	Gardner; William G.	H04M3/568	379/202.01
*	J	US-20160227338-A1	08-2016	OH; Hyunoh	H04S7/303	1/1
*	K	US-5438623-A	08-1995	Begault; Durand R.	H04S1/005	381/17
*	L	US-20030044002-A1	03-2003	Yeager, David M.	H04S7/302	379/444
*	M	US-20120183161-A1	07-2012	Agevik; Markus	H04S7/302	381/303

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
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U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20201208

<i>Notice of References Cited</i>	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.	
	Examiner AKELAW A TESHALE	Art Unit 2653	Page 2 of 2

U.S. PATENT DOCUMENTS

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	B					
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FOREIGN PATENT DOCUMENTS

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	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
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	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20201208

<i>Search Notes</i> 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHAE	Art Unit 2653

CPC - Searched*		
Symbol	Date	Examiner
H04S7/304, H04S7/303, H04R5/033, H04S3/008, H04S2400/01, H04S2420/01, H04S2400/11, H04S2420/01, H04S2400/11, H04S7/ 304, H04S7/303, H04S1/007, H04S2400/01, H04S7/305, H04S3/008 , H04S2400/15, H04S7/302, H04S1/002, H04S1/005, H04S7/30, H04S7/40, H04S2400/13, H04S7/301, H04S7/306, H04S2420/00, H04S5/00, H04S7/308	12/07/2020	AT

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor name search (east)	12/07/2020	AT
east search (US-PGPUB;USPAT;USOCR;FPRS;EPO;JPO; DERWENT;IBM_TDB)	12/07/2020	AT
Please see east search attachment	12/08/2020	AT

/AKELAW TESHAE/ Primary Examiner, Art Unit 2653	
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<i>Search Notes</i> 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
east interference search		12/07/2020	AT

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Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

CPC						
Symbol					Type	Version
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H04R	/	5	/	033	I	2013-01-01
H04S	/	3	/	008	I	2013-01-01
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CPC Combination Sets					
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NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	18	
/AKELAW TESHALE/ Primary Examiner, Art Unit 2653 (Primary Examiner)	08 December 2020 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 1

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Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

INTERNATIONAL CLASSIFICATION		
CLAIMED		
H04S	7	00
NON-CLAIMED		

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	18	
/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	08 December 2020	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

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Issue Classification 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

☐ Claims renumbered in the same order as presented by applicant
 ☐ CPA
 ☒ T.D.
 ☐ R.1.47

CLAIMS															
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(Assistant Examiner)	(Date)	18
/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	08 December 2020	O.G. Print Claim(s)
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EAST Search History

EAST Search History (Prior Art)

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S64	13	("20070086600" "20090023479" "20140198918" "20150098582" "20160066277" "20160112574" "20170013337" "20170181553" "20170339266" "20170364325" "4060696" "8447031" "9055156").PN. OR ("10009690").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 10:35
S65	12	("20120124470" "20140369506" "20150209668" "20160133051" "20160212272" "20160239252" "20160274358" "20160313973" "20170168562" "20170185148" "20170243600" "20180343534").PN. OR ("10602302").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 10:36
S66	6	("20170359467" "20180343534" "20190261125" "20190387351" "9699583" "9800990").PN. OR ("10602300").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 10:36
S67	160	S26 or S28 or S30 or S31 or S33 or S35 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45 or S46 or S47 or S48 or S49 or S50 or S51 or S52 or S53 or S54 or S55 or S57 or S58 or S59 or S61 or S62 or S63 or S64 or S65 or S66	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 11:22
S68	160	S26 or S28 or S30 or S31 or S33 or S35 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45 or S46 or S47 or S48 or S49 or S50 or S51 or S52 or S53 or S54 or S55 or S57	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO;	OR	OFF	2020/07/24 11:22

		or S58 or S59 or S61 or S62 or S63 or S64 or S65 or S66	DERWENT; IBM_TDB			
S69	192	(binaural near5 (sound or voice)) and (zone or area or section or region) and (headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 11:23
S70	23	S68 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 11:23
S71	58	(binaural near5 (sound or voice)) same (zone or area or section or region) same(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 12:14
S72	58	S71 AND ((H04S2420/01 OR H04S2400/11 OR H04S7/304 OR H04S7/302 OR H04S7/303 OR H04S2400/01 OR H04S7/40 OR H04S1/007 OR H04S1/005 OR H04S2400/13 OR H04S3/008 OR H04S2400/15 OR H04S7/305 OR H04S7/306 OR H04S7/30 OR H04S5/00 OR H04S2420/00 OR H04S1/002 OR H04R5/033 OR H04R5/04 OR H04R2499/11 OR H04R5/02 or H04S7/304 or H04S7/303 or H04R5/033 or H04S3/008 or H04S2400/01 or H04S2420/01 or H04S2400/11).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 12:19
S73	18	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 12:45
S74	17	("20060056638" "20060133619" "20060274901" "20080212788" "20100328419" "20110286614" "20130272527" "20130322667" "20150296289" "20150373477"	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 12:45

		"20160241986" "9412000").PN. OR ("9591427").URPN.				
S75	10	("20120213375" "20150373477" "5715317" "5982903" "9584653" "9584946").PN. OR ("9699583").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 12:45
S76	6	("8855341" "9031271" "9037468" "9088854" "9101299").PN. OR ("9674628").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 12:45
S77	8	("20090043591" "20100290636" "20140328505" "20150124975" "20150181355" "20150296086" "20160266865" "9037468").PN. OR ("10440490").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/07/24 12:45
S78	39	S74 or S75 or S76 or S77	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/24 12:46
S79	165	S78 or S68	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/24 12:46
S80	192	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 12:46
S81	23	S79 and S80	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 13:02
S82	194	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$7 adj2 point))))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 14:26

S92	3	((("C") near3 ("MATTER") near3 ("LIMITED"))).AS,AANM.	USPAT	OR	OFF	2020/07/29 08:30
S93	316	((("LYREN") near3 ("Philip")) OR ((("NORRIS") near3 ("Glen"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/07/29 08:30
S94	316	S92 or S93	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/07/29 08:30
S95	196	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$7 adj2 point)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/29 08:30
S96	178	S94 and S95	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/29 08:32
S97	4	((("C") near3 ("MATTER") near3 ("LIMITED"))).AS,AANM.	USPAT	OR	OFF	2020/12/06 20:25
S98	354	((("LYREN") near3 ("Philip")) OR ((("NORRIS") near3 ("Glen"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/12/06 20:26
S99	4	S97 and S98	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/12/06 20:28
S100	220	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$7 adj2 point)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/06 21:18
S101	218	((binaural near5 (sound or voice)) and (zone or area or section or region)	US-PGPUB; USPAT;	OR	ON	2020/12/06 21:27

		and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$7 adj2 point))) and (("3" dimension\$3) or "3"\$1dimension\$3 or (three dimension\$3) or (three\$1dimension\$3) or 3d or ("3" d) or stereo\$6 or parallax)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S102	218	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$7 adj2 point))) and (("3" dimension\$3) or "3"\$1dimension\$3 or (three dimension\$3) or (three\$1dimension\$3) or 3d or ("3" d) or parallax)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/06 21:27
S103	141	((binaural near5 (sound or voice)) same (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$7 adj2 point)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/06 21:43
S104	11	(binaural near5 (sound or voice)) same (zone or area or section or region) same(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$7 adj2 point)) same (("3" dimension\$3) or "3"\$1dimension\$3 or (three adj dimension\$3) or (three\$1dimension\$3) or 3d or ("3"adj d) or parallax)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/06 21:47
S105	2	("10063990" "9584653").PN. OR ("10154364").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/06 21:49
S106	11	("20120213375" "20150373477" "5715317" "5982903" "9584653" "9584946").PN. OR ("9699583").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/06 21:50
S107	7	("20160227338" "20150373477" "20080144794" "5715317" "9271080" "5438623" "20130163765").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:22
S108	6	("20120213375" "20150373477" "5715317" "5982903" "9584653" "9584946").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:23
S109	13	("20030044002" "9271080" "9584653" "20130163765" "5982903" "20120183161" "20080144794" "20150373477" "5438623" "20120213375" "20160227338" "5715317" "9584946").PN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:23
S110	202	(binaural near5 (sound or voice)) and (zone or area or section or region)	US-PGPUB; USPAT;	OR	ON	2020/12/07 19:31

		and(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$7 adj2 point)) and ("3" dimension\$3) or "3"\$1dimension\$3 or (three adj dimension\$3) or (three\$1dimension\$3) or 3d or ("3"adj d) or parallax)	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S111	2	("10063990" "9584653").PN. OR ("10154364").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:33
S112	11	("20120213375" "20150373477" "5715317" "5982903" "9584653" "9584946").PN. OR ("9699583").URPN.	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:33
S113	19	S107 or S108 or S109 or S111 or S112	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:33
S114	5	S110 and S113	US-PGPUB; USPAT; USOCR	OR	OFF	2020/12/07 19:35
S115	202	S110 AND ((H04S7/304 or H04S7/303 or H04R5/033 or H04S3/008 or H04S2400/01 or H04S2420/01 or H04S2400/11 or H04S2420/01 OR H04S2400/11 OR H04S7/304 OR H04S7/303 OR H04S1/007 OR H04S2400/01 OR H04S7/305 OR H04S3/008 OR H04S2400/15 OR H04S7/302 OR H04S1/002 OR H04S1/005 OR H04S7/30 OR H04S7/40 OR H04S2400/13 OR H04S7/301 OR H04S7/306 OR H04S2420/00 OR H04S5/00 OR H04S7/308).CPC.)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/07 19:56
S116	202	(binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$7 adj2 point)) and ("3" dimension\$3) or "3"\$1dimension\$3 or (three adj dimension\$3) or (three\$1dimension\$3) or "3d" or ("3"adj "d") or parallax)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/07 20:12
S117	18	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$7 adj2 point)) and ("3" dimension\$3) or "3"\$1dimension\$3 or (three adj dimension\$3) or (three\$1dimension\$3) or "3d" or ("3"adj "d") or parallax)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/12/07 20:23

EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S83	18	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))).clm.	US-PGPUB; USPAT	OR	ON	2020/07/24 12:29
S84	8	("20090043591" "20100290636" "20140328505" "20150124975" "20150181355" "20150296086" "20160266865" "9037468").PN. OR ("10440490").URPN.	US-PGPUB; USPAT	OR	OFF	2020/07/24 12:43
S85	17	("20060056638" "20060133619" "20060274901" "20080212788" "20100328419" "20110286614" "20130272527" "20130322667" "20150296289" "20150373477" "20160241986" "9412000").PN. OR ("9591427").URPN.	US-PGPUB; USPAT	OR	OFF	2020/07/24 12:44
S86	10	("20120213375" "20150373477" "5715317" "5982903" "9584653" "9584946").PN. OR ("9699583").URPN.	US-PGPUB; USPAT	OR	OFF	2020/07/24 12:44
S87	6	("8855341" "9031271" "9037468" "9088854" "9101299").PN. OR ("9674628").URPN.	US-PGPUB; USPAT	OR	OFF	2020/07/24 12:44
S88	8	("20090043591" "20100290636" "20140328505" "20150124975" "20150181355" "20150296086" "20160266865" "9037468").PN. OR ("10440490").URPN.	US-PGPUB; USPAT	OR	OFF	2020/07/24 12:44
S118	18	((binaural near5 (sound or voice)) and (zone or area or section or region) and(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$7 adj2 point)) and (("3" dimension\$3) or "3"\$1dimension\$3 or (three adj dimension\$3) or (three\$1dimension\$3) or "3d" or ("3"adj "d") or parallax)).clm.	US-PGPUB; USPAT	OR	ON	2020/12/07 20:30

12/8/2020 11:54:16 AM

C:\Users\ateshale\Documents\EAST\Workspaces\16558088.wsp

Document Description: Issue Fee Payment (PTO-85B)

Issue Fee Transmittal Form

Application Number	Filing Date	First Named Inventor	Atty. Docket No.	Confirmation No.
16558088	31-Aug-2019	Philip Lyren	PSL-037 (CON 4)	1238

TITLE OF INVENTION :

ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES

Entity Status	Application Type	Art Unit	Class - Subclass	EXAMINER
Small	Utility under 35 USC 111(a)	2653	303000	AKELAW TESHLE
Issue Fee Due	Publication Due	Total Fee(s) Due	Date Due	Prev. Paid Fee
\$600	\$0	\$600	10-Mar-2021	\$0

1.Change of Correspondence Address and/or Indication Of Fee Address (37 CFR 1.33 & 1.363)

Current Correspondence Address:	Current Indicated Fee Address :
64021 PHILIP S. LYREN, PC 289 Woodland Avenue Wadsworth OH 44281 UNITED STATES 216-539-0572 Philip_Lyren@yahoo.com	
☐ Change of correspondence address requested, system generated AIA/122-EFS form attached	☐ Fee Address indication requested, system generated SB/47-EFS form attached

2.Entity Status**Change in Entity Status**

Applicant certifying micro entity status; system generated Micro Entity certification form attached. See 37 CFR 1.29.

Note: Absent a valid certification of micro entity status, issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment. If this box is checked, you will be prompted to choose a micro entity status on the gross income basis (37 CFR 1.29(a)) or the institution of higher education basis (37 CFR 1.29(d)), and make the applicable certification online.



Applicant asserting small entity status. See 37 CFR 1.27.

Note: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.



Applicant changing to regular undiscounted fee status.

Note: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.



WEB IFEE 1.0

Document Description: Issue Fee Payment (PTO-85B)

3.The Following Fee(s) Are Submitted:☒ Issue Fee

I authorize USPTO to apply my previously paid issue fee to the current fees due

☐ Publication Fee

The Director is hereby authorized to apply my previously paid issue fee to the current fee due and to charge deficient fees to Deposit Account Number _____

☐ Advance Order - # of copies _____

If **in addition to** the payment of the issue fee amount submitted with this form, there are any discrepancies in any amount(s) due, the Director is authorized to charge any deficiency, or credit any overpayment, to Deposit Account Number _____ .

The **issue fee must be submitted** with this form. **If payment of the issue fee does not accompany this form, checking this box and providing a deposit account number will NOT be effective to satisfy full payment of the fee(s) due.**

4.Firm and/or Attorney Names To Be Printed**NOTE: If no name is listed, no name will be printed**

For printing on the patent front page, list to be displayed as entered

1.

2.

3.

5.Assignee Name(s) and Residence Data To Be Printed

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

Name	City	State	Country	Category
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6.Signature

I certify, in accordance with 37 CFR 1.4(d)(4) that I am an attorney or agent registered to practice before the Patent and Trademark Office who has filed and has been granted power of attorney in this application. I also certify that this Fee(s) Transmittal form is being transmitted to the USPTO via EFS-WEB on the date indicated below.

Signature	/Philip Lyren/	Date	12-10-2020
Name	Philip Scott Lyren	Registration Number	40709

WEB IFEE 1.0

Electronic Patent Application Fee Transmittal				
Application Number:		16558088		
Filing Date:		31-Aug-2019		
Title of Invention:		ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES		
First Named Inventor/Applicant Name:		Philip Scott Lyren		
Filer:		Philip Scott Lyren		
Attorney Docket Number:		PSL-037 (CON 4)		
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 APPL ISSUE FEE	2501	1	600	600
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
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 (\$)				600

Electronic Acknowledgement Receipt	
EFS ID:	41345237
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES
First Named Inventor/Applicant Name:	Philip Scott Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	10-DEC-2020
Filing Date:	31-AUG-2019
Time Stamp:	09:54:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$600
RAM confirmation Number	E2020B0054215561
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	Web85b.pdf	45236	no	2
			cb29f79c92aa975c5ad84300d75ffd8b36671f87		

Warnings:**Information:**

2	Fee Worksheet (SB06)	fee-info.pdf	32369	no	2
			dcbdd9a35f477ae6490c79c6e316545eb1550e94		

Warnings:**Information:**

Total Files Size (in bytes):			77605
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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.

Doc Code: DIST.E.FILE Document Description: Electronic Terminal Disclaimer - Filed		PTO/SB/26 U.S. Patent and Trademark Office Department of Commerce
Electronic Petition Request	TERMINAL DISCLAIMER TO OBTAIN A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	
Application Number	16558088	
Filing Date	31-Aug-2019	
First Named Inventor	Philip Lyren	
Attorney Docket Number	PSL-037 (CON 4)	
Title of Invention	ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES	
☒ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action ☒ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.		
Owner	Percent Interest	
C Matter Limited	100%	
The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s) 10750308 10587981 9699583 9800990		

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:

- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

☒ Terminal disclaimer fee under 37 CFR 1.20(d) is included with Electronic Terminal Disclaimer request.

☐ I certify, in accordance with 37 CFR 1.4(d)(4), that the terminal disclaimer fee under 37 CFR 1.20(d) required for this terminal disclaimer has already been paid in the above-identified application.

Applicant claims the following fee status:

☒ Small Entity

☐ Micro Entity

☐ Regular Undiscounted

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

☒ An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Registration Number 40709

☐ A sole inventor

☐ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application

☐ A joint inventor; all of whom are signing this request

Signature	/Philip Lyren/
Name	Philip Lyren

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal				
Application Number:		16558088		
Filing Date:		31-Aug-2019		
Title of Invention:		ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES		
First Named Inventor/Applicant Name:		Philip Scott Lyren		
Filer:		Philip Scott Lyren		
Attorney Docket Number:		PSL-037 (CON 4)		
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
STATUTORY OR TERMINAL DISCLAIMER	2814	1	170	170
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				170

Doc Code: DISQ.E.FILE

Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 16558088

Filing Date: 31-Aug-2019

Applicant/Patent under Reexamination: Lyren

Electronic Terminal Disclaimer filed on December 8, 2020

☒ APPROVED

This patent is subject to a terminal disclaimer

☐ DISAPPROVED

Approved/Disapproved by: Electronic Terminal Disclaimer automatically approved by EFS-Web

U.S. Patent and Trademark Office

Electronic Acknowledgement Receipt	
EFS ID:	41319699
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES
First Named Inventor/Applicant Name:	Philip Scott Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	08-DEC-2020
Filing Date:	31-AUG-2019
Time Stamp:	10:05:18
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$170
RAM confirmation Number	E2020B8A05156147
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	34919	no	3
			9bd1f0dfd35350e93688e03beb795d864b9d89c5		

Warnings:**Information:**

2	Fee Worksheet (SB06)	fee-info.pdf	30685	no	2
			315ada8a2fdd097c0c309b5f10e3770df3776005		

Warnings:**Information:**

Total Files Size (in bytes):			65604
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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.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Philip Lyren, et al.	Examiner:	Akelaw Teshale
Serial No.:	16/558,088	Group Art Unit:	2653
Filed:	31 August 2019	Docket No.:	PSL-037 (CON 4)
Title:	Defining a Zone with a HPED and Providing Binaural Sound in the zone		

RESPONSE TO OFFICE ACTION

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

In response to the Office Action mailed 30 July 2020, please enter the following amendments and consider the following remarks.

Amendments to the claims begin on page 2.

Remarks begin on page 8.

Amendments to the claims

This listing of claims will replace all prior versions, and listings, of the claims:

1. – 40. (canceled)

41. (currently amended) A method executed by one or more electronic devices, the method comprising:

tracking, with a wearable electronic device (WED) worn on a head of a user, movement of defining, with a handheld portable electronic device (HPED) held in a hand of the [[a]] user[[,]] such that the movement of the HPED defines a size and a shape of a three-dimensional (3D) zone that extends from a physical floor and around the user;

designating, with the HPED held in the hand of the user, a sound localization point (SLP) in empty space in the zone above the physical floor from where binaural sound originates to the user;

tracking, with the WED a wearable electronic device (WED) worn on the [[a]] head of the user, the HPED held in the hand of the user such that the HPED provides a location to the WED of the SLP in empty space in the zone above the physical floor from where the binaural sound originates to the user;

processing, by a processor, sound with head-related transfer functions (HRTFs) to generate the binaural sound that externally localizes to the user at the location of the SLP in empty space in the zone above the physical floor; and

displaying, with the WED worn on the head of the user, a virtual image at the location of the SLP in empty space in the zone above the physical floor from where the binaural sound originates to the user.

42. (previously presented) The method of claim 41, wherein the binaural sound is a voice of a virtual reality (VR) character that talks to the user while the user plays a VR game, and the voice externally localizes to the user at the VR character that

is at the location of the SLP in empty space in the zone above the physical floor.

43. (previously presented) The method of claim 41 further comprising:

tracking, with the WED worn on the head of the user, the HPED held in the hand of the user as the HPED moves in a trajectory having a shape of an arc;

processing, by the processor and with the HRTFs, the sound to generate SLPs of the binaural sound that moves through the empty space along the trajectory having the shape of the arc; and

displaying, with the WED worn on the head of the user, virtual images that follow the trajectory having the shape of the arc that shows the user the trajectory of the SLPs of the binaural sound moving through the empty space.

44. (previously presented) The method of claim 41 further comprising:

determining, with the WED worn on the head of the user, when a location of the user conflicts with a boundary of the zone; and

displaying, with the WED, the boundary of the zone to alert the user that the location of the user conflicts with the boundary of the zone.

45. (currently amended) The method of claim 41 further comprising:

displaying, with the WED worn on the head of the user, a virtual image of the zone as lines that extends from the physical floor and around the user,

wherein the zone has a customized shape drawn by user with the HPED, and the WED stores coordinate locations of the customized shape.

46. (previously presented) The method of claim 41 further comprising:

displaying, with the WED, a virtual monitor in a field of view (FOV) of the user;

processing, by the processor, the sound with the HRTFs to generate the binaural sound that originates from the virtual monitor; and

tracking, with the WED, head movements of the user to maintain the binaural sound originating from the virtual monitor as the head of the user moves.

47. (previously presented) The method of claim 41, wherein the zone has a shape of a cylinder that extends from the physical floor and around the user, and the WED displays the cylinder to the user.

48. (currently amended) A method executed by one or more electronic devices, the method comprising:

tracking, with a wearable electronic device (WED) worn on a head of a user, designating, with a handheld portable electronic device (HPED) that moves to define a shape of held in a hand of a user, a zone that extends from a physical floor and around the user holding the HPED in a hand;

designating, with the HPED held in the hand of the user, a sound localization point (SLP) for binaural sound at a location in empty space in the zone above the physical floor where the HPED is pointed;

tracking, with the WED ~~a wearable electronic device (WED)~~ worn on the ~~[[a]]~~ head of the user, the HPED and where the HPED is pointed to provide the WED with the location in empty space in the zone above the physical floor that includes the SLP for the binaural sound;

processing, by a processor, sound with head-related transfer functions (HRTFs) to produce the binaural sound that originates at the SLP at the location in empty space in the zone above the physical floor; and

displaying, with the WED worn on the head of the user, a virtual image at the location in empty space in the zone above the physical floor from where the binaural sound originates at the SLP to the user.

49. (previously presented) The method of claim 48 further comprising:

providing a voice as the binaural sound that externally localizes at the virtual image at the location in empty space in the zone above the physical floor, wherein the voice originates from a character in a virtual reality (VR) game that the user plays.

50. (currently amended) The method of claim 48 further comprising:

displaying, with the WED, a boundary of the zone with virtual lines to alert the user when the user conflicts with the boundary of the zone while the user plays a virtual reality (VR) game.

51. (previously presented) The method of claim 48 further comprising:

displaying the zone as a customized three-dimensional (3D) shape drawn by the user with the HPED held in the hand of the user.

52. (previously presented) The method of claim 48 further comprising:

tracking, with the WED, a location where the HPED is pointed as the HPED moves the SLP and the virtual image from one location where the HPED is pointed to another location where the HPED is pointed.

53. (previously presented) The method of claim 48 further comprising:

improving performance of the processor processing the sound by storing the HRTFs in a cache memory in the WED, wherein the processor is a digital signal processor (DSP) located in the WED.

54. – 60. (canceled)

61. (new) An electronic system, comprising:

a portable electronic device (PED) that moves to define a boundary of a three-dimensional (3D) zone extending from a physical floor on which a user holding the PED stands and around the user and that designates a sound localization point (SLP) in empty space inside the 3D zone; and

a wearable electronic device (WED) that is worn on a head of the user, tracks movement of the PED to determine the boundary of the 3D zone that extends from the physical floor and around the user, includes a processor that processes sound with head-related transfer functions (HRTFs) so sound externally localizes as binaural sound to the user at the SLP in empty space inside the 3D zone defined by movement of the PED, and displays a virtual image

at the SLP in empty space inside the 3D zone, and displays a 3D virtual image that shows the boundary of the 3D zone that extends from the physical floor and around the user.

62. (new) The electronic system of claim 61, wherein the 3D zone has a customized size and shape defined by movement of the PED while held in a hand of the user.

63. (new) The electronic system of claim 61, wherein the WED tracks the PED to determine when the PED is at the boundary of the 3D zone, and the WED automatically displays the 3D virtual image that shows the boundary of the 3D zone to alert the user that the PED is at the boundary of the 3D zone.

64. (new) The electronic system of claim 61, wherein the WED tracks the user to determine when the user is at the boundary of the 3D zone, and the WED automatically displays the 3D virtual image that shows the boundary of the 3D zone to alert the user that the user is at the boundary of the 3D zone.

65. (new) The electronic system of claim 61, wherein the WED determines a location of the user, stores the 3D zone for the location, and displays the 3D virtual image that shows the boundary of the 3D zone in response to determining that the user is at the location.

66. (new) The electronic system of claim 61, wherein the WED includes one or more sensors that track a light source in the PED to determine a location of the PED as the PED moves to define the boundary of the 3D zone, the WED displays a virtual monitor at the SLP in empty space inside the 3D zone, and the binaural sound continues originates to the user at the virtual monitor as the head of the user rotates to different orientations with respect to the virtual monitor.

67. (new) The electronic system of claim 61, wherein the WED displays the 3D virtual image that shows the boundary of the 3D zone as lines to enable the user to determine the boundary of the 3D zone.

Remarks

In the present response, 1 – 40 and 54 – 60 are canceled. Claims 61 – 67 are newly added. Claims 41 – 53 and 61 – 67 are presented for examination. No new matter is entered.

Claim Rejections: 35 USC 102

Claims 41-60 are rejected under 35 USC 102(a)(1) as being anticipated by US publication number 20130163765 (De Jong). Applicant traverses these rejections since claims 41-53 recite recitations not taught or even suggested in De Jong. Claims 54-60 are canceled, and the rejections are moot as to these claims.

Argument 1: De Jong Not Teach HPED that Moves to Define the Shape of the Zone

Independent claims 41 and 48 recite the HPED moves to define the zone. Specifically, independent claim 41 recites “the movement of the HPED defines a size and a shape of a three-dimensional (3D) zone that extends from a physical floor and around the user.” Independent claim 48 recites the HPED “moves to define a shape of a zone that extends from a physical floor and around the user holding the HPED in a hand.” De Jong does not teach or suggest these recitations.

In De Jong, the user enters a search into a search box via a keyboard or voice recognition technology (see para [0036]). Thereafter, the electronic device plays the results to the search in binaural sound. Different results of this search play to different locations around the head of the user. The user then uses a mouse, trackball, or joystick to point to and select the desired search result: “The user points to the desired result by pointing with a selection device 304, such as a mouse, trackball, or joystick, as shown in FIG. 3C.” (*Id.*). Thus, De Jong teaches an HPED that is used to point to and select a search result that is a location of where the user hears binaural sound.

De Jong uses the HPED in a manner that is completely different than the recitations of independent claims 41 and 48. As noted, these claims recite the

HPED moves to define the shape of the zone. Claim 41 recites the HPED moves to define a size and a shape of the 3D zone. Claim 48 recites the HPED moves to define a shape of a zone. Nowhere does De Jong teach or suggest an HPED that moves to define the shape of the zone as recited in claims 41 and 48. Instead, De Jong teaches using the HPED to point to and select a search result that is a location of where the user hears binaural sound.

For at least these reasons, claims 41-53 are allowable over De Jong.

Argument 2: De Jong Not Teach Wearable Electronic Device (WED) that Tracks HPED in Hand of the User

Independent claims 41 and 48 recite a wearable electronic device (WED) that is worn on a head of a user and that tracks a handheld portable electronic device (HPED). The Examiner argues that paragraphs [0030] and [0033] in De Jong teach a WED. Applicant respectfully disagrees.

Paragraph [0022] in De Jong gives examples of the electronic device for De Jong's invention. These examples include "a two-way radio, a cellular telephone, a mobile phone, a smartphone, a two-way pager, a wireless messaging device, a laptop/tablet/computer, a personal digital assistant, and other similar devices." None of these electronic devices are WEDs worn on the head of the user and track a HPED in the hand of the user.

Paragraph [0030] in De Jong teaches headphones that include a tracking sensor, such as a magnetometer or compass. This tracking sensor is used to track "the user head orientation with respect to the user's body." This tracking sensor, however, does not track an HPED as recited in claims 41 and 48. In fact, *the tracking sensor of magnetometer or compass is not capable of tracking another electronic device of an HPED as recited in claims 41 and 48.* Instead, the magnetometer and compass are used to track head movements of the user.

Paragraph [0033] in De Jong teaches that "binaural sound can be used to track moving targets, such as taxi cabs, buses, trains and/or emergency vehicles." This paragraph has no teaching whatsoever about a wearable electronic device worn on a head of a user that tracks the HPED as recited in claims 41 and 48.

Instead, this paragraph teaches tracking taxi cabs, buses, trains, and emergency vehicles, which are not handheld portable electronic devices or HPEDs held in the hand of the user.

Paragraphs [0030] and [0033] in De Jong thus fail to teach or suggest *WED worn on a head of the user* that tracks a HPED in a hand of the user as recited in claims 41 and 48.

For at least these reasons, claims 41-53 are allowable over De Jong.

New Claims

New claims 61-67 recite recitations not taught or suggested in De Jong. As one example, independent claim 61 recites “a portable electronic device (PED) that moves to define a boundary of a three-dimensional (3D) zone extending from a physical floor on which a user holding the PED stands.” De Jong does not teach or suggest these recitations. De Jong teaches a PED that points to and selects a search result that is a location of where the user hears binaural sound.

As another example, claim 61 recites “a wearable electronic device (WED) that is worn on a head of the user, tracks movement of the PED to determine the boundary of the 3D zone that extends from the physical floor and around the user.” De Jong does not teach a WED worn on a head of a user. Furthermore, the electronic device in De Jong does not track movement of the PED to determine the boundary of the 3D zone that extends from the physical floor and around the user. Instead, the PED in De Jong points to and selects a search result that is a location of where the user hears binaural sound.

Respectfully submitted,

/Philip S. Lyren #40,709/

Philip S. Lyren
Reg. No. 40,709
Ph: 216-539-0572

Electronic Acknowledgement Receipt	
EFS ID:	40555232
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES
First Named Inventor/Applicant Name:	Philip Scott Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	14-SEP-2020
Filing Date:	31-AUG-2019
Time Stamp:	22:46:09
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment/Req. Reconsideration-After Non-Final Reject	cover.pdf	17657	no	1
			038bb7f5c096a7667598663668dc4a388b4a9323		
Warnings:					

Information:					
2	Claims	claims.pdf	48834	no	6
			98ed25b78439f4fb3ddcf21427699cb6f9ec477		
Warnings:					
Information:					
3	Applicant Arguments/Remarks Made in an Amendment	remarks.pdf	51204	no	3
			f66374624cb3a1a25bca32fc06bd04c976508b3e		
Warnings:					
Information:					
Total Files Size (in bytes):			117695		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 16/558,088		Filing Date 08/31/2019		☐ To be Mailed	
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
		(Column 1)	(Column 2)						
FOR		NUMBER FILED	NUMBER EXTRA		RATE (\$)		FEE (\$)		
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A	N/A		N/A				
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A	N/A		N/A				
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A	N/A		N/A				
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =	*		x \$50 =				
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =	*		x \$230 =				
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.					TOTAL				
APPLICATION AS AMENDED - PART II									
		(Column 1)	(Column 2)		(Column 3)				
AMENDMENT	09/14/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(j))	* 20	Minus	** 20	= 0		x \$50 =		0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x \$230 =		0
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
								TOTAL ADD'L FEE	0
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(j))	*	Minus	**	=		x \$0 =		
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x \$0 =		
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
								TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.								LIE	
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".								/MARQUITA D JONES/	
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".									
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.									

This collection of information is required by 37 CFR 1.16. 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 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.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)	1238
64021	7590	07/30/2020	EXAMINER	
PHILIP S. LYREN, PC 289 Woodland Avenue Wadsworth, OH 44281			TESHALE, AKELAW	
			ART UNIT	PAPER NUMBER
			2653	
			MAIL DATE	DELIVERY MODE
			07/30/2020	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

DETAILED ACTION

1. Preliminary amendment filed on 06/12/2020 is considered.

Claim Rejections - 35 USC § 102

2. In the event the determination of the status of the application as subject to AIA 35 U.S.C. 102 and 103 (or as subject to pre-AIA 35 U.S.C. 102 and 103) is incorrect, any correction of the statutory basis for the rejection will not be considered a new ground of rejection if the prior art relied upon, and the rationale supporting the rejection, would be the same under either status.

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(1) the claimed invention was patented, described in a printed publication, or in public use, on sale or otherwise available to the public before the effective filing date of the claimed invention.

4. **Claims 41-60** are rejected under 35 U.S.C. 102 (a) (1) as being anticipated by U.S. Pub No. 20130163765 A1 to De Jong et al. (hereinafter “De Jong”).

Regarding **claim 41**, De Jong discloses a method executed by one or more electronic devices, the method comprising:

defining, with a handheld portable electronic device (HPED) held in a hand of a user, a three-dimensional (3D) zone that extends from a physical floor and around the user (paragraphs [0027] and [0028]; sound localization in a 3D space using binaural sounds represents information from the wireless communication device 100);

designating, with the HPED held in the hand of the user, a sound localization point (SLP) in empty space in the zone above the physical floor from where binaural sound originates to the user (paragraphs [0045]; binaural sound that seems to come from a particular point in space. Stated differently, the two ears of a human can locate sounds in three dimensions in range (distance), in direction above and below, in front and to the rear, as well as to either side),

tracking, with a wearable electronic device (WED) worn on a head of the user, the HPED held in the hand of the user such that the HPED provides a location to the WED of the SLP in empty space in the zone above the physical floor from where the binaural sound originates to the user (paragraphs [0030] and [0033]; position of the head with respect to the body can be tracked and the binaural navigation automatically compensated to user's current head orientation. A tracking sensor, such as a magnetometer or compass can be tied into the headphones of the device the user is wearing);

processing, by a processor, sound with head-related transfer functions (HRTFs) to generate the binaural sound that externally localizes to the user at the location of the SLP in empty space in the zone above the physical floor; and displaying, with the WED worn on the head of the user, a virtual image at the location of the SLP in empty space in the zone above the physical floor from where the binaural sound originates to the user (paragraphs [0043] - [0046]; HRTF is a response that characterizes how an ear receives a sound from a point in space; a pair of HRTFs for two ears can be used to synthesize a binaural sound that seems to come from a particular point in space. Stated differently, the two ears of a human can locate sounds in three dimensions in range

(distance), in direction above and below, in front and to the rear, as well as to either side).

Regarding **claim 42**, De Jong discloses the method of claim 41, wherein the binaural sound is a voice of a virtual reality (VR) character that talks to the user while the user plays a VR game, and the voice externally localizes to the user at the VR character that is at the location of the SLP in empty space in the zone above the physical floor (paragraphs [0030] and [0033]; position of the head with respect to the body can be tracked and the binaural navigation automatically compensated to user's current head orientation. A tracking sensor, such as a magnetometer or compass can be tied into the headphones of the device the user is wearing).

Regarding **claim 43**, De Jong discloses the method of claim 41 further comprising:

tracking, with the WED worn on the head of the user, the HPED held in the hand of the user as the HPED moves in a trajectory having a shape of an arc;

processing, by the processor and with the HRTFs, the sound to generate SLPs of the binaural sound that moves through the empty space along the trajectory having the shape of the arc; and displaying, with the WED worn on the head of the user, virtual images that follow the trajectory having the shape of the arc that shows the user the trajectory of the SLPs of the binaural sound moving through the empty space (paragraphs [0030] and [0033]; position of the head with respect to the body can be tracked and the binaural navigation automatically compensated to user's current head

orientation. A tracking sensor, such as a magnetometer or compass can be tied into the headphones of the device the user is wearing).

Regarding **claim 44**, De Jong discloses the method of claim 41 further comprising:

determining, with the WED worn on the head of the user, when a location of the user conflicts with a boundary of the zone; and displaying, with the WED, the boundary of the zone to alert the user that the location of the user conflicts with the boundary of the zone (paragraphs [0027] and [0028]).

Regarding **claim 45**, De Jong discloses the method of claim 41 further comprising:

displaying, with the WED worn on the head of the user, a virtual image of the zone that extends from the physical floor and around the user, wherein the zone has a customized shape drawn by user with the HPED, and the WED stores coordinate locations of the customized shape (paragraph [0055]; binaural sound sequence including a nominal ear spacing and ear shape of a particular user for sound localization in a 3D space).

Regarding **claim 46**, De Jong discloses the method of claim 41 further comprising:

displaying, with the WED, a virtual monitor in a field of view (FOV) of the user; processing, by the processor, the sound with the HRTFs to generate the binaural sound

that originates from the virtual monitor; and tracking, with the WED, head movements of the user to maintain the binaural sound originating from the virtual monitor as the head of the user moves (paragraphs [0030] and [0033]).

Regarding **claim 47**, De Jong discloses the method of claim 41, wherein the zone has a shape of a cylinder that extends from the physical floor and around the user, and the WED displays the cylinder to the use (paragraphs [0027] and [0028] and [0055]).

Regarding **claim 48**, De Jong discloses a method executed by one or more electronic devices, the method comprising:

designating, with a handheld portable electronic device (HPED) held in a hand of a user, a zone that extends from a physical floor and around the user (paragraphs [0027] and [0028]; sound localization in a 3D space using binaural sounds represents information from the wireless communication device 100);

designating, with the HPED held in the hand of the user, a sound localization point (SLP) for binaural sound at a location in empty space in the zone above the physical floor where the HPED is pointed (paragraphs [0045]; binaural sound that seems to come from a particular point in space. Stated differently, the two ears of a human can locate sounds in three dimensions in range (distance), in direction above and below, in front and to the rear, as well as to either side);

tracking, with a wearable electronic device (WED) worn on a head of the user, the HPED and where the HPED is pointed to provide the WED with the location in

empty space in the zone above the physical floor that includes the SLP for the binaural sound (paragraphs [0030] and [0033]; position of the head with respect to the body can be tracked and the binaural navigation automatically compensated to user's current head orientation. A tracking sensor, such as a magnetometer or compass can be tied into the headphones of the device the user is wearing);

processing, by a processor, sound with head-related transfer functions (HRTFs) to produce the binaural sound that originates at the SLP at the location in empty space in the zone above the physical floor (paragraphs [0043] - [0046]; HRTF is a response that characterizes how an ear receives a sound from a point in space; a pair of HRTFs for two ears can be used to synthesize a binaural sound that seems to come from a particular point in space. Stated differently, the two ears of a human can locate sounds in three dimensions in range (distance), in direction above and below, in front and to the rear, as well as to either side); and

displaying, with the WED worn on the head of the user, a virtual image at the location in empty space in the zone above the physical floor from where the binaural sound originates at the SLP to the user (paragraphs [0027] and [0028]).

Regarding **claim 49**, De Jong discloses the method of claim 48 further comprising:

providing a voice as the binaural sound that externally localizes at the virtual image at the location in empty space in the zone above the physical floor, wherein the voice originates from a character in a virtual reality (VR) game that the user plays (paragraphs [0026] and [0036]).

Regarding **claim 50**, De Jong discloses the method of claim 48 further comprising:

displaying, with the WED, a boundary of the zone to alert the user when the user conflicts with the boundary of the zone while the user plays a virtual reality (VR) game (paragraphs [0026]-[0028]).

Regarding **claim 51**, De Jong discloses the method of claim 48 further comprising:

displaying the zone as a customized three-dimensional (3D) shape drawn by the user with the HPED held in the hand of the user (paragraph [0055]).

Regarding **claim 52**, De Jong discloses the method of claim 48 further comprising:

tracking, with the WED, a location where the HPED is pointed as the HPED moves the SLP and the virtual image from one location where the HPED is pointed to another location where the HPED is pointed (paragraphs [0045]).

Regarding **claim 53**, De Jong discloses the method of claim 48 further comprising:

improving performance of the processor processing the sound by storing the HRTFs in a cache memory in the WED, wherein the processor is a digital signal processor (DSP) located in the WED (paragraphs [0037] and [0038]).

Regarding **claim 54**, De Jong discloses a non-transitory computer-readable storage medium that stores instructions that one or more electronic devices execute as a method comprising:

defining, with a handheld portable electronic device (HPED) that is in a hand of a user, a boundary of a zone that extends from a floor and around the user (paragraphs [0027] and [0028]; sound localization in a 3D space using binaural sounds represents information from the wireless communication device 100);

designating, where the HPED is pointed while in the hand of the user, a location of a sound localization point (SLP) in empty space in the zone above the floor for where binaural sound originates to the user (paragraphs [0045]; binaural sound that seems to come from a particular point in space. Stated differently, the two ears of a human can locate sounds in three dimensions in range (distance), in direction above and below, in front and to the rear, as well as to either side);

tracking, with a wearable electronic device (WED) worn on a head of the user, where the HPED is pointed to provide the WED with the location of the SLP in empty space in the zone above the floor for the binaural sound (paragraphs [0030] and [0033]; position of the head with respect to the body can be tracked and the binaural navigation automatically compensated to user's current head orientation. A tracking sensor, such as a magnetometer or compass can be tied into the headphones of the device the user is wearing);

processing, by one or more processors, sound with head-related transfer functions (HRTFs) to produce the binaural sound that originates to the user where the

HPED is pointed at the location of the SLP in empty space in the zone above the floor; and displaying, with the WED worn on the head of the user, a virtual image where the HPED is pointed at the location of the SLP in empty space in the zone above the floor (paragraphs [0043] - [0046]; HRTF is a response that characterizes how an ear receives a sound from a point in space; a pair of HRTFs for two ears can be used to synthesize a binaural sound that seems to come from a particular point in space. Stated differently, the two ears of a human can locate sounds in three dimensions in range (distance), in direction above and below, in front and to the rear, as well as to either side).

Regarding **claim 55**, De Jong discloses the non-transitory computer-readable storage medium of claim 54 with the method further comprising:

detecting, with the WED, when the user conflicts with the boundary of the zone; and alerting the user that the user conflicts with the boundary of the zone by displaying, with the WED, the boundary of the zone (paragraphs [0027] and [0028]).

Regarding **claim 56**, De Jong discloses the non-transitory computer-readable storage medium of claim 54 with the method further comprising:

displaying, with WED, a virtual monitor in a field of view (FOV) of the user; and processing, with the one or more processors in the WED, the sound with the HRTFs so the binaural sound originates from the virtual monitor (paragraphs [0030] and [0033]).

Regarding **claim 57**, De Jong discloses the non-transitory computer-readable storage medium of claim 54 with the method further comprising:

tracking, with the WED, the HPED as the HPED moves in a trajectory having an S-shape in the zone above the floor (paragraphs [0030] and [0033]);

processing, by the one or more processors, the sound with the HRTFs to generate SLPs that exist along the trajectory having the S-shape in the zone above the floor (paragraphs [0030] and [0033]); and

displaying, with the WED worn on the head of the user, virtual images along the trajectory having the S-shape in the zone above the floor (paragraphs [0027] and [0028]).

Regarding **claim 58**, De Jong discloses the non-transitory computer-readable storage medium of claim 54 with the method further comprising:

receiving, at a microphone in the WED, a verbal instruction from the user that causes the WED to move the SLP and the virtual image from the location in empty space in the zone above the floor to another location in empty space in the zone above the floor (paragraphs [0027] and [0028]).

Regarding **claim 59**, De Jong discloses the non-transitory computer-readable storage medium of claim 54 with the method further comprising:

displaying, with the WED worn on the head of the user, a virtual image of the boundary of the zone that extends from the floor and around the user, wherein the zone has a customized shape drawn by user with the HPED (paragraph [0055]).

Regarding **claim 60**, De Jong discloses the non-transitory computer-readable storage medium of claim 54, wherein the zone is shaped as a three-dimensional (3D) cylinder that extends from the floor and surrounds the user, and the WED displays the 3D cylinder that extends from the floor and surrounds the user (paragraphs [0027] and [0028] and [0055]).

Conclusion

5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to AKELAW A TESHAE whose telephone number is (571)270-5302. The examiner can normally be reached on 9 am -6pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Fan Tsang can be reached on (571)272-7547. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <https://ppair->

my.uspto.gov/pair/PrivatePair. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

AKELAW TESHLE
Primary Examiner
Art Unit 2653

/AKELAW TESHLE/
Primary Examiner, Art Unit 2653

<i>Notice of References Cited</i>	Application/Control No. 16/558,088		Applicant(s)/Patent Under Reexamination Lyren et al.	
	Examiner AKELAW A TESHALE		Art Unit 2653	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20130163765-A1	06-2013	De Jong; Janice Leigh	H04S7/304	381/17
*	B	US-9271080-B2	02-2016	Mahabub; Jerry	H04R5/00	1/1
	C					
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FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

U.S. Patent and Trademark Office
PTO-892 (Rev. 01-2001)

Notice of References Cited

Part of Paper No. 20200724A

<i>Search Notes</i> 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

CPC - Searched*		
Symbol	Date	Examiner
H04S2420/01, H04S2400/11, H04S7/304, H04S7/302, H04S7/303, H04S2400/01, H04S7/40, H04S1/007, H04S1/005, H04S2400/13, H04S3/008, H04S2400/15, H04S7/305, H04S7/306, H04S7/30, H04S5/00, H04S2420/00, H04S1/002, H04R5/033, H04R5/04, H04R2499/11, H04R5/02, H04S7/304, H04S7/303, H04R5/033, H04S3/008, H04S2400/01, H04S2420/01, H04S2400/11	07/24/2020	AT

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Inventor name search (east)	07/29/2020	AT
east search (US-PGPUB;USPAT;USOCR;FPRS;EPO;JPO;DERWENT;IBM_TDB)	07/24/2020	AT
Please see east search attachment	07/29/2020	AT

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	
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<i>Search Notes</i> 	Application/Control No. 16/558,088	Applicant(s)/Patent Under Reexamination Lyren et al.
	Examiner AKELAW A TESHALE	Art Unit 2653

/AKELAW TESHALE/ Primary Examiner, Art Unit 2653	
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✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS										
☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47										
CLAIM		DATE								
Final	Original	07/29/2020								
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	39	-								
	40	-								
	41	✓								
	42	✓								

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CLAIM		DATE								
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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	3	((("C") near3 ("MATTER") near3 ("LIMITED"))).AS,AANM.	USPAT	OR	OFF	2020/07/23 10:09
S2	313	((("LYREN") near3 ("Philip"))) OR ((("NORRIS") near3 ("Glen"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/07/23 10:09
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S8	313	((("LYREN") near3 ("Philip"))) OR ((("NORRIS") near3 ("Glen"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/07/23 16:19
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S10	223	binaural and (zone or area or section or region) and (headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/23 16:41
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S12	58	binaural same (zone or area or section or region) same (headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/23 21:52
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S19	186	(binaural near5 (sound or voice)) and (zone or area or section or region) and (headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/24 08:28
S20	192	(binaural near5 (sound or voice)) and (zone or area or section or region) and (headrelat\$4 or HRTF or (head adj relat\$4)) and (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 08:28
S21	58	(binaural near5 (sound or voice)) same (zone or area or section or region) same(headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$6 adj2 point))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 10:01
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S23	180	((binaural near5 (sound or voice)) and (zone or area or section or region)) and ((headrelat\$4 or HRTF or (head adj relat\$4)) same (SLP or (local\$6 adj2 point)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 10:17

S24	226	((binaural near5 (sound or voice)) same (SLP or (local\$6 adj2 point)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 10:25
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S68	160	S26 or S28 or S30 or S31 or S33 or S35 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45 or S46 or S47 or S48 or S49 or S50 or S51 or S52 or S53 or S54 or S55 or S57 or S58 or S59 or S61 or S62 or S63 or S64 or S65 or S66	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/24 11:22

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S70	23	S68 and S69	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2020/07/24 11:23
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S79	165	S78 or S68	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/07/24 12:46
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S92	3	((("C") near3 ("MATTER") near3 ("LIMITED"))).AS,AANM.	USPAT	OR	OFF	2020/07/29 08:30

S93	316	((("LYREN") near3 ("Philip"))) OR (("NORRIS") near3 ("Glen"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/07/29 08:30
S94	316	S92 or S93	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2020/07/29 08:30
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EAST Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
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7/29/2020 8:49:45 AM

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Bibliographic Data

Application No: 16/558,088

Foreign Priority claimed: ☐ Yes ☒ No

35 USC 119 (a-d) conditions met: ☐ Yes ☒ No ☐ Met After Allowance

Verified and Acknowledged: /AKELAW TESHAE/

Examiner's Signature

Initials

Title:

ELECTRONIC CALL IN BINAURAL SOUND WITH
SMARTPHONE AND ELECTRONIC GLASSES

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
08/31/2019	381	2653	PSL-037 (CON 4)
RULE			

APPLICANTS

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Glen A. Norris, Tokyo, JAPAN

CONTINUING DATA

This application is a CON of 15635166 06/27/2017 PAT 10587981

15635166 is a CON of 15429131 02/09/2017 PAT 9699583

15429131 is a CON of 15365880 11/30/2016 PAT 9800990

15365880 has PRO of 62348164 06/10/2016

FOREIGN APPLICATIONS

IF REQUIRED, FOREIGN LICENSE GRANTED**

09/11/2019

**** SMALL ENTITY ****

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Philip Lyren, et al.	Examiner:	Akelaw Teshale
Serial No.:	16/558,088	Group Art Unit:	2653
Filed:	31 August 2019	Docket No.:	PSL-037 (CON 4)
Title:	Defining a Zone with a HPED and Providing Binaural Sound in the zone		

PRELIMINARY AMENDMENT FOR CONTINUING APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Please enter the following amendments for this continuing application.
Claims 1-40 are canceled, and claims 41-60 are newly added. Applicant also amends the title and abstract. No new matter is entered.

Respectfully submitted,

/Philip S. Lyren #40,709/

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Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of the claims:

1. – 40. (canceled)

41. (new) A method executed by one or more electronic devices, the method comprising:

defining, with a handheld portable electronic device (HPED) held in a hand of a user, a three-dimensional (3D) zone that extends from a physical floor and around the user;

designating, with the HPED held in the hand of the user, a sound localization point (SLP) in empty space in the zone above the physical floor from where binaural sound originates to the user;

tracking, with a wearable electronic device (WED) worn on a head of the user, the HPED held in the hand of the user such that the HPED provides a location to the WED of the SLP in empty space in the zone above the physical floor from where the binaural sound originates to the user;

processing, by a processor, sound with head-related transfer functions (HRTFs) to generate the binaural sound that externally localizes to the user at the location of the SLP in empty space in the zone above the physical floor; and

displaying, with the WED worn on the head of the user, a virtual image at the location of the SLP in empty space in the zone above the physical floor from where the binaural sound originates to the user.

42. (new) The method of claim 41, wherein the binaural sound is a voice of a virtual reality (VR) character that talks to the user while the user plays a VR game, and the voice externally localizes to the user at the VR character that is at the location of the SLP in empty space in the zone above the physical floor.

43. (new) The method of claim 41 further comprising:

tracking, with the WED worn on the head of the user, the HPED held in the hand of the user as the HPED moves in a trajectory having a shape of an arc;

processing, by the processor and with the HRTFs, the sound to generate SLPs of the binaural sound that moves through the empty space along the trajectory having the shape of the arc; and

displaying, with the WED worn on the head of the user, virtual images that follow the trajectory having the shape of the arc that shows the user the trajectory of the SLPs of the binaural sound moving through the empty space.

44. (new) The method of claim 41 further comprising:

determining, with the WED worn on the head of the user, when a location of the user conflicts with a boundary of the zone; and

displaying, with the WED, the boundary of the zone to alert the user that the location of the user conflicts with the boundary of the zone.

45. (new) The method of claim 41 further comprising:

displaying, with the WED worn on the head of the user, a virtual image of the zone that extends from the physical floor and around the user,

wherein the zone has a customized shape drawn by user with the HPED, and the WED stores coordinate locations of the customized shape.

46. (new) The method of claim 41 further comprising:

displaying, with the WED, a virtual monitor in a field of view (FOV) of the user;

processing, by the processor, the sound with the HRTFs to generate the binaural sound that originates from the virtual monitor; and

tracking, with the WED, head movements of the user to maintain the binaural sound originating from the virtual monitor as the head of the user moves.

47. (new) The method of claim 41, wherein the zone has a shape of a cylinder that extends from the physical floor and around the user, and the WED displays

the cylinder to the user.

48. (new) A method executed by one or more electronic devices, the method comprising:

- designating, with a handheld portable electronic device (HPED) held in a hand of a user, a zone that extends from a physical floor and around the user;

- designating, with the HPED held in the hand of the user, a sound localization point (SLP) for binaural sound at a location in empty space in the zone above the physical floor where the HPED is pointed;

- tracking, with a wearable electronic device (WED) worn on a head of the user, the HPED and where the HPED is pointed to provide the WED with the location in empty space in the zone above the physical floor that includes the SLP for the binaural sound;

- processing, by a processor, sound with head-related transfer functions (HRTFs) to produce the binaural sound that originates at the SLP at the location in empty space in the zone above the physical floor; and

- displaying, with the WED worn on the head of the user, a virtual image at the location in empty space in the zone above the physical floor from where the binaural sound originates at the SLP to the user.

49. (new) The method of claim 48 further comprising:

- providing a voice as the binaural sound that externally localizes at the virtual image at the location in empty space in the zone above the physical floor, wherein the voice originates from a character in a virtual reality (VR) game that the user plays.

50. (new) The method of claim 48 further comprising:

- displaying, with the WED, a boundary of the zone to alert the user when the user conflicts with the boundary of the zone while the user plays a virtual reality (VR) game.

51. (new) The method of claim 48 further comprising:
displaying the zone as a customized three-dimensional (3D) shape drawn by the user with the HPED held in the hand of the user.
52. (new) The method of claim 48 further comprising:
tracking, with the WED, a location where the HPED is pointed as the HPED moves the SLP and the virtual image from one location where the HPED is pointed to another location where the HPED is pointed.
53. (new) The method of claim 48 further comprising:
improving performance of the processor processing the sound by storing the HRTFs in a cache memory in the WED, wherein the processor is a digital signal processor (DSP) located in the WED.
54. (new) A non-transitory computer-readable storage medium that stores instructions that one or more electronic devices execute as a method comprising:
defining, with a handheld portable electronic device (HPED) that is in a hand of a user, a boundary of a zone that extends from a floor and around the user;
designating, where the HPED is pointed while in the hand of the user, a location of a sound localization point (SLP) in empty space in the zone above the floor for where binaural sound originates to the user;
tracking, with a wearable electronic device (WED) worn on a head of the user, where the HPED is pointed to provide the WED with the location of the SLP in empty space in the zone above the floor for the binaural sound;
processing, by one or more processors, sound with head-related transfer functions (HRTFs) to produce the binaural sound that originates to the user where the HPED is pointed at the location of the SLP in empty space in the zone above the floor; and
displaying, with the WED worn on the head of the user, a virtual image where the HPED is pointed at the location of the SLP in empty space in the zone above the floor.

55. (new) The non-transitory computer-readable storage medium of claim 54 with the method further comprising:

detecting, with the WED, when the user conflicts with the boundary of the zone; and

alerting the user that the user conflicts with the boundary of the zone by displaying, with the WED, the boundary of the zone.

56. (new) The non-transitory computer-readable storage medium of claim 54 with the method further comprising:

displaying, with WED, a virtual monitor in a field of view (FOV) of the user; and

processing, with the one or more processors in the WED, the sound with the HRTFs so the binaural sound originates from the virtual monitor.

57. (new) The non-transitory computer-readable storage medium of claim 54 with the method further comprising:

tracking, with the WED, the HPED as the HPED moves in a trajectory having an S-shape in the zone above the floor;

processing, by the one or more processors, the sound with the HRTFs to generate SLPs that exist along the trajectory having the S-shape in the zone above the floor; and

displaying, with the WED worn on the head of the user, virtual images along the trajectory having the S-shape in the zone above the floor.

58. (new) The non-transitory computer-readable storage medium of claim 54 with the method further comprising:

receiving, at a microphone in the WED, a verbal instruction from the user that causes the WED to move the SLP and the virtual image from the location in empty space in the zone above the floor to another location in empty space in the zone above the floor.

59. (new) The non-transitory computer-readable storage medium of claim 54 with the method further comprising:

displaying, with the WED worn on the head of the user, a virtual image of the boundary of the zone that extends from the floor and around the user,

wherein the zone has a customized shape drawn by user with the HPED.

60. (new) The non-transitory computer-readable storage medium of claim 54, wherein the zone is shaped as a three-dimensional (3D) cylinder that extends from the floor and surrounds the user, and the WED displays the 3D cylinder that extends from the floor and surrounds the user.

Electronic Acknowledgement Receipt	
EFS ID:	39780586
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International Application Number:	
Confirmation Number:	1238
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First Named Inventor/Applicant Name:	Philip Scott Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
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Filing Date:	31-AUG-2019
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Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	cover.pdf	18515	no	1
			87478cb1b768da5e5c1c77ff2322efcc14deccb9		
Warnings:					

Information:					
2	Specification	specification.pdf	24741	no	2
			6dc9e523efc995f7fbb2f18af3bafdf5c815f2e6		
Warnings:					
Information:					
3	Claims	claims.pdf	57094	no	6
			7e3bcb99bccb9eb728e8c7dec6d2efc63bb7d1aa		
Warnings:					
Information:					
Total Files Size (in bytes):			100350		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					

Amendments to the Specification

Please amend the title of the invention as follows:

Defining a Zone with a HPED and Providing Binaural Sound in the Zone
~~Electronic Call in Binaural Sound with Smartphone and Electronic Glasses~~

Amendments to the Specification

Please amend the abstract of the invention as follows:

A handheld portable electronic device (HPED) defines a zone that extends from a floor and around a user wearing a wearable electronic device (WED). The HPED designates a location in the zone for where binaural sound originates to the user. The WED tracks a location of the HPED, and sound is processed to originate as the binaural sound in the zone. The WED displays a virtual image at the location of the binaural sound in the zone. A first user and a second user have an electronic call in binaural sound. A smartphone processes a voice of the second user to externally localize as the binaural sound. Wearable electronic glasses worn on a head of the first user communicate with the smartphone and display a virtual image at a location where the voice of the second user externally localizes to the first user.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 16/558,088		Filing Date 08/31/2019		☐ To be Mailed	
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
		(Column 1)	(Column 2)						
FOR		NUMBER FILED	NUMBER EXTRA		RATE (\$)		FEE (\$)		
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A	N/A		N/A				
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A	N/A		N/A				
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A	N/A		N/A				
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =	*		x \$50 =				
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =	*		x \$230 =				
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.					TOTAL				
APPLICATION AS AMENDED - PART II									
		(Column 1)	(Column 2)		(Column 3)				
AMENDMENT	06/21/2020	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(j))	* 20	Minus	** 20	= 0		x \$50 =		0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x \$230 =		0
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
								TOTAL ADD'L FEE	0
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(j))	*	Minus	**	=		x \$0 =		
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x \$0 =		
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
								TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.								SLIE	
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".								/NATASHA OMAR/	
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".									
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.									

This collection of information is required by 37 CFR 1.16. 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 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.**

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/558,088	08/31/2019	Philip Scott Lyren	PSL-037 (CON 4)

CONFIRMATION NO. 1238

64021
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

PUBLICATION NOTICE



Title:ELECTRONIC CALL IN BINAURAL SOUND WITH SMARTPHONE AND ELECTRONIC GLASSES

Publication No.US-2019-0387351-A1

Publication Date:12/19/2019

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publicly available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently <http://www.uspto.gov/patft/>.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

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Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Philip Lyren, et al.	Examiner:	Akelaw Teshale
Serial No.:	16/558,088	Group Art Unit:	2653
Filed:	31 August 2019	Docket No.:	PSL-037 (CON 4)
Title:	Electronic Call in Binaural Sound with Smartphone and Electronic Glasses		

PRELIMINARY AMENDMENT FOR CONTINUING APPLICATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Please enter the following amendments for this continuing application.

Respectfully submitted,

/Philip S. Lyren #40,709/

Philip S. Lyren
Reg. No. 40,709
Ph: 216-539-0572

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of the claims:

1. – 20. (canceled)

21. (new) A method executed by one or more electronic devices for an electronic call between a first user and a second user, the method comprising:

receiving, at a smartphone of the first user, an electronic call from the second user;

designating, from motion of the smartphone that is in a hand of the first user, a sound localization point (SLP) for binaural sound that is located in a physical environment of the first user;

processing, with the smartphone, a voice of the second user so the voice of the second user originates to the first user as the binaural sound at the SLP; and

displaying, with electronic glasses worn by the first user and in wireless communication with the smartphone, a virtual image that represents the second user at the SLP.

22. (new) The method of claim 21 further comprising:

receiving, at a microphone, a verbal instruction from the first user that describes a new location for the SLP from where the voice of the second user will originate to the first user as the binaural sound; and

moving, by the smartphone, the voice of the second user to the new location of the SLP, wherein the new location of the SLP is in empty space outside a head of the first user and is located above one of a table or a chair.

23. (new) The method of claim 21 further comprising:

processing, with the smartphone, the voice of the second user to generate SLPs of the binaural sound that moves through empty space in a trajectory

having a shape of an arc around a head of the first user; and

displaying, with the electronic glasses worn on the head of the first user, virtual images that follow the trajectory having the shape of the arc to show the first user the trajectory of the SLPs of the binaural sound moving through the empty space.

24. (new) The method of claim 21 further comprising:

sharing, from an intelligent user agent (IUA) of the first user to an IUA of the second user, sound localization information (SLI) that includes coordinate a coordinate location of the SLP.

25. (new) The method of claim 21 further comprising:

displaying, with the electronic glasses, a virtual monitor in a field of view (FOV) of the first user; and
processing, with the smartphone, the voice of the second user to originate from the virtual monitor.

26. (new) The method of claim 21 further comprising:

displaying, with the electronic glasses, the SLP as an augmented reality (AR) image shaped as a sphere at the SLP to notify the first user where the SLP exists in the physical environment of the first user.

27. (new) The method of claim 21 further comprising:

assisting the first user in distinguishing between naturally occurring sound and the binaural sound by playing, with speakers in the electronic glasses, an alert sound that externally localizes at the SLP that is on a surface of a physical object in the physical environment of the first user.

28. (new) The method of claim 28, wherein the motion of the smartphone designates the SLP to be on a surface of a physical object in the physical environment of the first user.

29. (new) A non-transitory computer-readable storage medium that stores instructions that one or more electronic devices execute for an electronic call between a first user and a second user, the method comprising:

designating, with a smartphone that is in a hand of the first user, a location on top of a physical object that will be a sound localization point (SLP) for binaural sound;

processing, with the smartphone, a voice of the second user so the voice of the second user originates to the first user as the binaural sound at the SLP located on top of the physical object; and

displaying, with electronic glasses worn by the first user and in wireless communication with the smartphone, a virtual image that represents the second user at the SLP located on top of the physical object.

30. (new) The non-transitory computer-readable storage medium of claim 29 with the method further comprising:

displaying, with electronic glasses worn by the first user and in wireless communication with the smartphone, an augmented reality (AR) sphere to show the first user where the voice of the second user will externally localize when the first user answers the electronic call from the second user.

31. (new) The non-transitory computer-readable storage medium of claim 29 with the method further comprising:

tracking, with the electronic glasses, a gaze of the first user; and

switching the binaural sound to stereo sound when the gaze of the first user is no longer directed to the virtual image.

32. (new) The non-transitory computer-readable storage medium of claim 29, wherein the physical object is a wall.

33. (new) The non-transitory computer-readable storage medium of claim 29, wherein the physical object is one of a chair or a table.

34. (new) A method executed by one or more electronic devices for an electronic call between a first user and a second user, the method comprising:

receiving, at a smartphone of the first user, an electronic call from the second user;

receiving, at a microphone, a verbal instruction from the first user that describes a location from where a voice of the second user will originate to the first user as binaural sound;

processing, with the smartphone, the voice of the second user so the voice originates to the first user as the binaural sound from the location; and

displaying, with electronic glasses worn by the first user and in wireless communication with the smartphone, a virtual image that represents the second user at the location.

35. (new) The method of claim 34 further comprising:

displaying, with the electronic glasses and before the first user answers the electronic call from the second user, a recommended location from where the voice of the second user will originate to the first user as the binaural sound.

36. (new) The method of claim 34, wherein the location is on top of a physical object that is a non-electronic device in an environment of the first user.

37. (new) The method of claim 34 further comprising:

minimizing perceptual errors where the binaural sound originates to the first user by displaying, with the electronic glasses worn on the head of the first user, the virtual image shaped as a sphere at the location on top of a physical object from where the binaural sound originates to the first user, wherein the voice of the second user originates to the first user from inside the sphere.

38. (new) The method of claim 34 further comprising:

detecting, with a camera in the electronic glasses, a gesture from the first user that commands the smartphone to move the voice of the second user from originating at the location to originating at another location in empty space in an

environment of the first user.

39 (new) The method of claim 34 further comprising:

determining a location from where the voice of the second user previously localized to the first user in a previous electronic call with the second user; and

displaying, with the electronic glasses and before the first user answers the electronic call from the second user, a recommended location that is the location from where the voice of the second user previously localized to the first user in the previous electronic call with the second user.

40. (new) The method of claim 34 further comprising:

processing, with the smartphone, the binaural sound to localize only in a zone that matches a portion of a virtual environment in a range of gaze of the first user while not providing sound in the virtual environment that is outside the range of gaze of the first user.

Electronic Acknowledgement Receipt	
EFS ID:	37140789
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	Selecting a Location to Localize Binaural Sound
First Named Inventor/Applicant Name:	Philip Scott Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	12-SEP-2019
Filing Date:	31-AUG-2019
Time Stamp:	09:12:23
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment		no			
File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Preliminary Amendment	cover.pdf	15612	no	1
			a1ad5e53005a40a5b848f20b17314fba24160507		
Warnings:					

Information:					
2	Specification	specification.pdf	36876	no	4
			0ec3a9a78a7281678c081de42589666c2e04aedf		
Warnings:					
Information:					
3	Claims	claims.pdf	48482	no	5
			199fd7b7ec73c3c15fc0f07f336e3a604c8e44f8		
Warnings:					
Information:					
Total Files Size (in bytes):			100970		
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					



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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
16/558,088	08/31/2019		985	PSL-037 (CON 4)	20	3

CONFIRMATION NO. 1238

FILING RECEIPT



CC000000111061739

64021
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

Date Mailed: 09/12/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Philip Scott Lyren, Bangkok, THAILAND;
Glen A. Norris, Tokyo, JAPAN;

Applicant(s)

C Matter Limited, Wadsworth, OH;

Power of Attorney: The patent practitioners associated with Customer Number 64021

Domestic Priority data as claimed by applicant

This application is a CON of 15/635,166 06/27/2017
which is a CON of 15/429,131 02/09/2017 PAT 9699583
which is a CON of 15/365,880 11/30/2016 PAT 9800990
which claims benefit of 62/348,164 06/10/2016

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: No

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 09/11/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/558,088**

Projected Publication Date: 12/19/2019

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

Selecting a Location to Localize Binaural Sound

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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page 2 of 4

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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/558,088			
APPLICATION AS FILED - PART I									
(Column 1)		(Column 2)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY			
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)		
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	330		N/A			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A			
TOTAL CLAIMS (37 CFR 1.16(i))	20 minus 20 =	*	x 50 =	0.00	OR				
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3 minus 3 =	*	x 230 =	0.00					
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			200					
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00					
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	985		TOTAL			
APPLICATION AS AMENDED - PART II									
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)	
	Total (37 CFR 1.16(i))	*	Minus **	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))					OR			
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR			
			TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE			
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR OTHER THAN SMALL ENTITY	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)	ADDITIONAL FEE(\$)	
	Total (37 CFR 1.16(i))	*	Minus **	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))					OR			
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR			
			TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.									

Amendments to the Specification

Please amend the title of the invention as follows:

Electronic Call in Binaural Sound with Smartphone and Electronic Glasses
~~Selecting a Location to Localize Binaural Sound~~

Please amend page 54 at lines 28 and 30 as follows:

Example actions include, but are not limited to, one or more of the following:
storing HRTFs and/or other SLI in cache memory, local memory, or other memory or registers near or close to the processor (e.g., a DSP) executing an example embodiment, mapping and storing coordinates and/or locations of SLPs and/or zones of users so this coordinate information is known in advance (e.g., before sound for a requesting software application convolves to a SLP or zone), storing coordinates and/or locations of SLPs and/or zones in cache memory, local memory, or other memory near or close to the processor (e.g., a DSP) executing an example embodiment, prefetching HRTFs and/or SLI, prefetching coordinates and/or locations of SLPs and/or zones of users, storing HRTFs and/or SLI in a lookup table, storing HRTFs and/or SLI with or as part of an audio file, wirelessly transmitting the HRTFs, SLI, SLPs, and/or zones with or as part of the audio file, predicting where a user will externally localize sound and prefetching or preprocessing HRTFs and/or SLI and coordinates of SLPs and/or zones in response to this prediction, configuring specialized or customized hardware to execute one or more of these actions (e.g., configuring logic gates or logic blocks in a FPGA to execute ~~executes~~ blocks in figures, as opposed to executing software instructions in a processor to execute the blocks in the figures), and taking other actions discussed herein (e.g., with respect to hardware such as the DSP, cache memory, and prefetcher).

Please amend page 62 at line 12 as follows:

Consider an example in which the location of the user with respect to an object is used to prefetch data. For example, a user is 1.5 meters away from an object or other external localization point that might serve as a SLP for a telephone call, game, or voice of an IPA. The object is at a same elevation as a head of the user. This distance of 1.5 meters remains relatively fixed, though the head orientation of the user changes or moves. In response to this information, the system prefetches SLPs and corresponding HRTF pairs that have a distance of 1.5 meters with an elevation of zero degrees. For example, the system prefetches SLPs and/or HRTFs corresponding to (1.5m, X° , 0°), where X is an integer. Here, the X represents different azimuth angles to which the user might move his or her head when sound convolving commences. For instance, the system retrieves HRTF data corresponding to (1.5m, 0° , 0°), (1.5m, 5° , 0°), (1.5m, 10° , 0°), (1.5m, 15° , 0°), ... (1.5m, 355° , 0°). Alternatively, the system retrieves other azimuth intervals, such as retrieving HRTF data for every 3° , 6° , 10° , 15° , 20° , or 25° . When convolution commences, the data for the particular azimuth angle has already been retrieved and is available in cache or local memory for the processor to quickly expedite convolution of the sound.

Amendments to the Specification

Please amend page 106 at line 9 as follows:

By way of example, a computer and a [[an]] portable electronic device include, but are not limited to, handheld portable electronic devices (HPEDs), wearable electronic glasses, watches, wearable electronic devices (WEDs) or wearables, smart earphones or hearables, voice control devices (VCD), voice personal assistants (VPAs), network attached storage (NAS), printers and peripheral devices, virtual devices or emulated devices (e.g., device simulators, soft devices), cloud resident devices, computing devices, electronic devices with cellular or mobile phone capabilities, digital cameras, desktop computers, servers, portable computers (such as tablet and notebook computers), smartphones, electronic and computer game consoles, home entertainment systems, digital audio players (DAPs) and handheld audio playing devices (example, handheld devices for downloading and playing music and videos), appliances (including home appliances), head mounted displays (HMDs), optical head mounted displays (OHMDs), personal digital assistants (PDAs), electronics and electronic systems in automobiles (including automobile control systems), combinations of these devices, devices with a processor or processing unit and a memory, and other portable and non-portable electronic devices and systems (such as electronic devices with a DSP).

Amendments to the Specification

Please amend the abstract of the invention as follows:

A first user and a second user have an electronic call in binaural sound. A smartphone processes a voice of the second user to externally localize as the binaural sound. Wearable electronic glasses worn on a head of the first user communicate with the smartphone and display a virtual image at a location where the voice of the second user externally localizes to the first user. A method
~~selects a location where to localize binaural sound to a listener. Sounds are assigned to different zones or different sound localization points (SLPs). The sounds are convolved with sound localization information so the sounds externally localize as binaural sound away from the listener and into the assigned zone or to the assigned SLP.~~

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 16/558,088		Filing Date 08/31/2019		☐ To be Mailed	
ENTITY: ☐ LARGE ☒ SMALL ☐ MICRO									
APPLICATION AS FILED - PART I									
		(Column 1)	(Column 2)						
FOR		NUMBER FILED	NUMBER EXTRA		RATE (\$)		FEE (\$)		
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))		N/A	N/A		N/A				
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))		N/A	N/A		N/A				
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))		N/A	N/A		N/A				
TOTAL CLAIMS (37 CFR 1.16(i))		minus 20 =	*		x \$50 =				
INDEPENDENT CLAIMS (37 CFR 1.16(h))		minus 3 =	*		x \$230 =				
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))		If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).							
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.					TOTAL				
APPLICATION AS AMENDED - PART II									
		(Column 1)	(Column 2)		(Column 3)				
AMENDMENT	09/12/2019	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(j))	* 20	Minus	** 20	= 0		x \$50 =		0
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3	= 0		x \$230 =		0
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
							TOTAL ADD'L FEE		0
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(j))	*	Minus	**	=		x \$0 =		
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x \$0 =		
	☐ Application Size Fee (37 CFR 1.16(s))								
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))								
							TOTAL ADD'L FEE		
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.							LIE		
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".							/CORALIA BETANCOURT/		
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".									
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.									

This collection of information is required by 37 CFR 1.16. 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 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.

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.

UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(b))</i>	Attorney Docket No.	PSL-037 (CON 4)
	First Inventor	Philip Scott Lyren
	Title	Selecting a Location to Localize Binaural Sound
	Express Mail Label No.	

APPLICATION ELEMENTS See MPEP chapter 600 concerning utility patent application contents.	ADDRESS TO: Commissioner for Patents P.O. Box 1450 Alexandria VA 22313-1450
1. ☐ Fee Transmittal Form. (PTO/SB/17 or equivalent) 2. ☒ Applicant claims small entity status. See 37 CFR 1.27. 3. ☒ Specification. [Total Pages <u>130</u>] Both the claims and abstract must start on a new page (For information on the preferred arrangement, see MPEP § 608.01(a)) 4. ☒ Drawing(s). (35 U.S.C. 113) [Total Sheets <u>18</u>] 5. Inventor's Oath or Declaration. [Total Sheets <u>3</u>] (including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e)) a. ☒ Newly executed (original or copy) b. ☐ A copy from a prior application (37 CFR 1.63(d)) 6. ☒ Application Data Sheet. *See Note below. See 37 CFR 1.76 (PTO/AIA/14 or equivalent) 7. ☐ CD-ROM or CD-R. in duplicate, large table or Computer Program (Appendix) ☐ Landscape Table on CD 8. Nucleotide and/or Amino Acid Sequence Submission. (if applicable, items a. – c. are required) a. ☐ Computer Readable Form (CRF) b. ☐ Specification Sequence Listing on: i. ☐ CD-ROM or CD-R (2 copies); or ii. ☐ Paper c. ☐ Statements verifying identity of above copies	ACCOMPANYING APPLICATION PARTS 9. ☐ Assignment Papers. (cover sheet & document(s)) Name of Assignee _____ 10. ☐ 37 CFR 3.73(c) Statement. ☐ Power of Attorney. (when there is an assignee) 11. ☐ English Translation Document. (if applicable) 12. ☐ Information Disclosure Statement. (PTO/SB/08 or PTO-1449) ☐ Copies of citations attached 13. ☐ Preliminary Amendment. 14. ☐ Return Receipt Postcard. (MPEP § 503) (Should be specifically itemized) 15. ☐ Certified Copy of Priority Document(s). (if foreign priority is claimed) 16. ☐ Nonpublication Request. Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent. 17. ☐ Other: _____

***Note:** (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must** be included in an Application Data Sheet (ADS).
 (2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

18. CORRESPONDENCE ADDRESS					
☒ The address associated with Customer Number: <u>64021</u> OR ☐ Correspondence address below					
Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	
Signature		/Philip Lyren, #40,709/		Date 31 August 2019	
Name (Print/Type)		Philip Lyren		Registration No. (Attorney/Agent) 40,709	

This collection of information is required by 37 CFR 1.53(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.

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	PSL-037 (CON 4)
		Application Number	
Title of Invention	Selecting a Location to Localize Binaural Sound		
<p>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.</p> <p>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.</p>			

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				<input type="button" value="Remove"/>
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Philip	Scott	lyren		
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service					
City	Bangkok	Country of Residence ⁱ	TH		
Mailing Address of Inventor:					
Address 1	289 Woodland Avenue				
Address 2					
City	Wadsworth	State/Province	OH		
Postal Code	44281	Country ⁱ	US		
Inventor	2				<input type="button" value="Remove"/>
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Glen	A.	Norris		
Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service					
City	Tokyo	Country of Residence ⁱ	JP		
Mailing Address of Inventor:					
Address 1	1244 Arlington Road				
Address 2					
City	Lakewood	State/Province	OH		
Postal Code	44107	Country ⁱ	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. <input type="button" value="Add"/>					

Correspondence Information:

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-037 (CON 4)
		Application Number	
Title of Invention	Selecting a Location to Localize Binaural Sound		

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	64021		
Email Address	philip_lyren@yahoo.com	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>

Application Information:

Title of the Invention	Selecting a Location to Localize Binaural Sound		
Attorney Docket Number	PSL-037 (CON 4)	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	18	Suggested Figure for Publication (if any)	

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	64021		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-037 (CON 4)
		Application Number	
Title of Invention	Selecting a Location to Localize Binaural Sound		

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 this 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 blank.

Prior Application Status		Pending		Remove	
Application Number		Continuity Type		Prior Application Number	Filing Date (YYYY-MM-DD)
		Continuation of		15635166	2017-06-27
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15635166	Continuation of	15429131	2017-02-09	9699583	2017-07-04
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15429131	Continuation of	15365880	2016-11-30	9800990	2017-10-24
Prior Application Status		Expired		Remove	
Application Number		Continuity Type		Prior Application Number	Filing Date (YYYY-MM-DD)
15365880		Claims benefit of provisional		62348164	2016-06-10
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)ⁱ 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).

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-037 (CON 4)
		Application Number	
Title of Invention	Selecting a Location to Localize Binaural Sound		

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.

Authorization to Permit Access:

☒ Authorization to Permit Access to the Instant Application by the Participating Offices

If 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 World Intellectual Property Office (WIPO), and any other intellectual property offices in which a foreign application claiming priority to the instant patent application is filed access to the instant patent application. See 37 CFR 1.14(c) and (h). This box should not be checked if the applicant does not wish the EPO, JPO, KIPO, WIPO, or other intellectual property office in which a foreign application claiming priority to the instant patent application is filed to have access to the instant patent application.

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the instant patent application with respect to: 1) the instant patent application-as-filed; 2) any foreign application to which the instant patent application claims priority under 35 U.S.C. 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the instant patent application; and 3) any U.S. application-as-filed from which benefit is sought in the instant patent application.

In accordance with 37 CFR 1.14(c), access may be provided to information concerning the date of filing this Authorization.

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.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-037 (CON 4)
		Application Number	
Title of Invention	Selecting a Location to Localize Binaural Sound		

Applicant	1	<input type="button" value="Remove"/>
<p>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.</p> <div><input type="button" value="Clear"/></div>		
☒ 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:		
<div></div>		
Name of the Deceased or Legally Incapacitated Inventor : <div></div>		
If the Applicant is an Organization check here. ☒		
Organization Name	C Matter Limited	
Mailing Address Information For Applicant:		
Address 1	289 Woodland Ave	
Address 2		
City	Wadsworth	State/Province OH
Country	US	Postal Code 44281
Phone Number	216-539-0572	Fax Number
Email Address		
Additional Applicant Data may be generated within this form by selecting the Add button. <input type="button" value="Add"/>		

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
<p>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.</p> <div><input type="button" value="Remove"/></div>	
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-037 (CON 4)
		Application Number	
Title of Invention	Selecting a Location to Localize Binaural Sound		

Prefix	Given Name	Middle Name	Family Name	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		State/Province	
Country ⁱ		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Signature	/Philip Lyren, #40,709/		Date (YYYY-MM-DD)	2019-08-31
First Name	Philip	Last Name	Lyren	Registration Number
				40709

Additional Signature may be generated within this form by selecting the Add button.

This collection of information is required by 37 CFR 1.76. 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 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet 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.**

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)		Attorney Docket Number	PSL-037 (CON 4)
		First Named Inventor	Philip Scott Lyren
☒ Declaration Submitted With Initial Filing OR ☐ Declaration Submitted After Initial Filing (surcharge (37 CFR 1.16(f)) required)		COMPLETE IF KNOWN	
		Application Number	
		Filing Date	
		Art Unit	
		Examiner Name	

Selecting a Location to Localize Binaural Sound

(Title of the Invention)

As a below named inventor, I hereby declare that:

This declaration is directed to:

☒ The attached application,

OR

☐ United States Application Number or PCT International application number _____
filed on _____.

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

I believe 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.

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[Page 1 of 2]

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LEGAL NAME OF SOLE OR FIRST INVENTOR:						
(E.g., Given Name (first and middle (if any)) and Family Name or Surname)						
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☒ Additional inventors are being named on the <u>one</u> supplemental sheet(s) PTO/AIA/10 attached hereto						

[Page 2 of 2]

DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet
Page <u>one</u> of <u>one</u>	

Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor	
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Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
Inventor's Signature		Date	
Residence: City	State	Country	Citizenship
Mailing Address			
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Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor	
Given Name (first and middle (if any))		Family Name or Surname	
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Selecting a Location to Localize Binaural Sound

BACKGROUND

- 5 Three-dimensional (3D) sound localization offers people a wealth of new technological avenues to not merely communicate with each other but also to communicate more efficiently with electronic devices, software programs, and processes.
- 10 As this technology develops, challenges will arise with regard to how sound localization integrates into the modern era. Example embodiments offer solutions to some of these challenges and assist in providing technological advancements in methods and apparatus using 3D sound localization.

15

SUMMARY

One example embodiment is a method that selects a location where binaural sound localizes to a listener. Sounds are assigned to different zones or different
5 sound localization points (SLPs) and are convolved so the sounds localize as binaural sound into the assigned zone or to the assigned SLP.

Other example embodiments are discussed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a method to divide an area around a user into zones in accordance with an example embodiment.

5

Figure 2 is a method to select where to externally localize binaural sound to a listener based on information about the sound in accordance with an example embodiment.

10 Figure 3 is a method to store assignments of SLPs and/or zones in accordance with an example embodiment.

Figure 4 shows a coordinate system with zones or groups of SLPs around a head of a user in accordance with an example embodiment.

15

Figure 5A shows a table of example historical audio information that can be stored for a user in accordance with an example embodiment.

20 Figure 5B shows a table of example SLP and/or zone designations or assignments of a user for localizing different sound sources in accordance with an example embodiment.

25 Figure 5C shows a table of example SLP and/or zone designations or assignments of a user for localizing miscellaneous sound sources in accordance with an example embodiment.

Figure 6 is a method to select a SLP and/or zone for where to localize sound to a user in accordance with an example embodiment.

30 Figure 7 is a method to resolve a conflict with a designation of a SLP and/or zone in accordance with an example embodiment.

Figure 8 is a method to execute an action to increase or improve performance of a computer providing binaural sound to externally localize to a user in accordance with an example embodiment.

5

Figure 9 is a method to increase or improve performance of a computer by expediting convolving and/or processing of sound to localize at a SLP in accordance with an example embodiment.

10 Figure 10 is a method to process and/or convolve sound so the sound externally localizes as binaural sound to a user in accordance with an example embodiment.

Figures 11A – 11E show a coordinate system with a plurality of zones having different azimuth coordinates in accordance with an example embodiment.

15

Figures 12A – 12E show a coordinate system with a plurality of zones having different elevation coordinates in accordance with an example embodiment.

Figures 13A – 13E provide example configurations or shapes of zones in 3D space in accordance with example embodiments.

20

Figure 14 is a computer system or electronic system in accordance with an example embodiment.

25 Figure 15 is a computer system or electronic system in accordance with an example embodiment.

Figure 16 is an example of sound localization information in the form of a file in accordance with an example embodiment.

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Figure 17 is an example of a sound localization information configuration in accordance with an example embodiment.

5

5

DETAILED DESCRIPTION

Example embodiments include method and apparatus that provide binaural sound to a listener.

5

Example embodiments include methods and apparatus that improve performance of a computer, electronic device, or computer system that executes, processes, convolves, transmits, and/or stores binaural sound that externally localizes to a listener. These example embodiments also solve a myriad of technical problems and challenges that exist with executing, processing, convolving, transmitting, and storing binaural sound.

10

Figure 1 is a method to divide an area around a user into zones in accordance with an example embodiment.

15

Block 100 states divide an area around a user into one or more zones.

The area or space around the user is divided, partitioned, separated, mapped, or segmented into one or more three-dimensional (3D) zones, two-dimensional (2D) zones, and/or one-dimensional (1D) zones defined in 3D space with respect to the user.

20

These zones can partially or fully extend around or with respect to the user. For example, one or more zones extend fully around all sides of a head and/or body of the user. As another example, one or more zones exist within a field-of-view of the user. As another example, an area above the head of the user includes a zone.

25

Consider an example in which a head of a listener is centered or at an origin in polar coordinates, spherical coordinates, 3D Cartesian coordinates, or another coordinate system. A 3D space or area around the head is further divided,

30

partitioned, mapped, separated, or segmented into multiple zones or areas that are defined according to coordinates in the coordinate system.

The zones can have distinct boundaries, such as volumes, planes, lines, or points defined with coordinates, functions or equations (e.g., defined per a function of a straight line, a curved line, a plane, or other geometric shape). For example, X-Y-Z coordinates or spherical coordinates define a boundary or perimeter of a zone or define one or more sides or edges or starting and/or ending locations.

Zones are not limited to having a distinct boundary. For example, zones have general boundaries. For instance, a 3D volume around a head of a listener is separated into one or more of a front area (e.g., an area in front of the face of the listener), a top area (e.g., a region above the head of the listener), a left side area (e.g., a section to a left of the listener), a right side area (e.g., a volume to a right of the listener), a back area (e.g., a space behind a head of the listener), a bottom area (e.g., an area below a waist of the listener), an internal area (e.g., an area inside the head or between the ears of a listener).

A zone can encompass a unique or distinct area, such as each zone being separate from other zones with no overlapping area or intersection. Alternatively, one or more zones can share one or more points, line segments, areas or surfaces with another zone, such as one zone sharing a boundary along a line or plane with another zone. Further, zones can have overlapping or intersecting points, lines, 2D and/or 3D areas or regions, such as a zone located in front of a face of a listener overlapping with a zone located to a right side of a head of the listener.

Zones can have a variety of different shapes. These shapes include, but are not limited to, a sphere, a hemisphere, a cylinder, a cone (including frustoconical shapes), a box or a cube, a circle, a square or rectangle, a triangle, a point or

location in space, a prism, curved lines, straight lines or line segments, planes, planar sections, polygons, irregular 2D or 3D shapes, and other 1D, 2D and 3D shapes.

- 5 Zones can have similar, same, or different shapes and sizes. For example, a user has a dome-shaped zone or hemi-spherical shaped zone above a head, a first pie-shaped zone on a left side, a second pie-shaped zone on a right side, and a partial 3D cylindrically-shaped zone behind the head.
- 10 Zones can have a variety of different sizes. For example, zones include near-field audio space (e.g., 1.0 meter or less from the listener) and/or far-field audio space (e.g., 1.0 meter or more away from the listener). A zone can extend or exist within a definitive distance around a user. For instance, the zone extends from 1.0 meter to 2.0 meters away from a head or body of a listener. Alternatively, a
- 15 zone can extend or exist within an approximate distance. For instance, the zone extends from about 1.0 meter (e.g., 0.9 m – 1.1 m) to about 3.0 meters (e.g., 2.7 m – 3.3 m) away from a head of a listener. Further, a zone can extend or exist within an uncertain or variable distance. For instance, a zone extends from approximately 3 feet from a head of a listener to a farthest distance that the
- 20 particular listener can localize a sound, with such distance differing from one listener to another listener.

- Zones can vary in number, such as having one zone, two zones, three zones, four zones, five zones, six zones, etc. Further, a number of zones can differ from
- 25 one user to another user (e.g., a first user has three zones, and a second user has five zones).

- The shape, size, and/or number of zones can be fixed or variable. For example, a listener has a front zone, a left zone, a right zone, a top zone, and a rear zone;
- 30 and these zones are fixed or permanent in one or more of their size, shape, and number. As another example, a listener has a top zone, a left zone, and a right

zone; and these zones are changeable or variable in one or more of their size, shape, and number.

5 The shape, size, and/or number of zones can be customized or unique to a particular user such that two users have a different shape, size, and/or number of zones. The definition of the customized zones and other information can be stored and retrieved (e.g., stored as user preferences).

10 Block 110 states designate one or more sound localization points (SLPs) for the zone(s).

As one example, one or more SLPs define the boundaries or area of a zone. Here, the locations of the SLPs define the zone, the endpoints of a zone, the perimeter of the zone, the boundary of the zone, the vertices of a zone, or
15 represent a zone defined by a function that fits the locations (e.g., a zone defined by a function for a smooth curving plane in which the locations are included in the range). For example, three SLPs form an arc that partially extends around a head of a listener. This arc is a zone. As another example, four SLPs are on a parabolic surface that partially extends around a head of a listener. This surface
20 is a zone, and the SLPs are included in the range of the function that defines this zone. As another example, the four SLPs are on the surface of an irregular volume zone that is partially defined by the SLPs. As another example, the locations represent a zone defined by the space that is included within one foot of each SLP.

25 As another example, a perimeter or boundary of a 2D or 3D area defines a zone, and SLPs located in, on, or near this area are designated for the zone. For example, a zone is defined as being a cube whose sides are 0.3 m in length and whose center is located 1.5 meters from a face of a user. SLPs located on a
30 surface or within a volume of this cube are designated for the zone.

A SLP and likewise a zone can be defined with respect to the location and orientation of the head or body of the listener, or the physical or virtual environment of the listener. For example, the location of the SLP is defined by a general position relative to the listener (e.g., left of the head, in front of the face, behind the ears, above the head, right of the chest, below the waist, etc.), or a position with respect to the environment of the listener (e.g., at the nearest exit, at the nearest person, above the device, at the north wall, at the crosswalk). This information can also be more specific with X-Y-Z coordinates, spherical coordinates, polar coordinates, compass direction, distance direction, etc.

10

Consider an example in which each SLP has a spherical or Cartesian coordinate location with respect to a head orientation of a user (e.g., with an origin at a point midway between the ears of a listener), and each zone is defined with coordinate locations or other boundary information (e.g., a geometric formula or algebraic function) with respect to the head of the user.

15

Consider an example in which a zone is defined relative to a listener without regard to existing SLPs. By way of example, zone A is defined with respect to a head of the listener in which the listener is at an origin. Zone A includes the area between 1.0 m – 2.0 m from the head of the listener with azimuth coordinates between 0° – 45° and with elevation coordinates between 0° – 30°. SLPs having coordinates within this defined area are located in Zone A.

20

Zones can also be defined by the location of SLPs. For example, Zone A is defined by a series or set of SLPs that are along a line segment that is defined in an X-Y-Z coordinate system. The SLPs along or near this line segment are designated as being in Zone A. As another example, Zone B is defined by a series or set of SLPs that localize sound from a particular sound source (e.g., a telephony application) or that localize sound of a particular type (e.g., voices).

25

30

Consider an example in which a zone and corresponding SLPs are defined according to a geometric equation or geometric 2D or 3D shape. For example, a zone is a hemisphere having a radius (r) with a head of a user located at a center of this hemisphere. SLPs within Zone A are defined as being in a portion of the hemisphere with $0 \text{ m} \leq r \leq 1.0 \text{ m}$; and SLPs within Zone B are defined as being in another portion of the hemisphere with $1.0 \text{ m} \leq r \leq 2.0 \text{ m}$.

In an example embodiment, a zone can be or include one or more SLPs. For example, a top zone located above a head of a listener is defined by or located at a single SLP with spherical coordinates (1.0 m , 0° , 90°). As another example, two or more SLPs each within one foot of each other define a zone. As another example, a group of SLPs between the azimuth angles of 0° and 45° define a zone. These examples are provided to illustrate a few of the many different ways SLPs and zones can be arranged.

A zone can have a distinct or a definitive number of SLPs (e.g., one SLP, two SLPs, three SLPs, ... ten SLPs, ... fifty SLPs, etc.). This number can be fixed or variable. For example, a number of SLPs in a zone vary over time, vary based on a physical or virtual location of the listener, vary based on which type of sound is localizing to the zone (e.g., voice or music or alert), vary based on which software application is requesting sound to localize, etc.

A zone can have no SLPs. For example, some zones represent areas or locations where sound should not be externally localized to a listener. For instance, such areas or locations include, but are not limited to, directly behind a head of a person, in an area known as a cone of confusion of a person, beneath or below a person, or other locations deemed inappropriate or undesirable for external localization of binaural sound, or a particular sound, sound type, or sound source, for a particular time of day, or geographic or virtual location, or for a particular listener. Further, areas where binaural sound is designated not to localize may be temporary or change based on one or more factors. For example,

binaural sound does not localize to a zone or area behind a head of a person when a wall or other physical obstruction exists in this area.

A zone can have SLPs but one or more of these SLPs are inactive or not usable.

- 5 For example, zone A has twenty SLPs, but only three of these SLPs are available for locations to localize sound from a particular software application that provides a voice to a user. The other seventeen SLPs are available for locations to localize music from a music library of the user or available to localize other types of sound or sound from other software applications or sound sources.

10

Block 120 states determine sound localization information (SLI) for the zone(s) and/or SLP(s) so sound processed and/or convolved with the SLI localizes to the designated zone and/or SLP to the user.

- 15 Sound localization information (SLI) is information that is used to process or convolve sound so the sound externally localizes as binaural sound to a listener. Sound localization information includes all or part of the information necessary to describe and/or render the localization of a sound to a listener. For example, SLI is in the form a file with partial localization information, such as a direction of
- 20 localization from a listener, but without a distance. An example SLI file includes convolved sound. Another example SLI file includes the information necessary to convolve the sound or in order to otherwise achieve a particular localization. As another example, a SLI file includes complete information as a single file to provide a computer program (such as a media player or a process executing on
- 25 an electronic device) with data and/or instructions to localize a particular sound along a complex path around a particular listener.

- Consider an example of a media player application that parses various SLI components from a single sound file that includes the SLI incorporated into the
- 30 header of the sound file. The single file is played multiple times, and/or from different devices, or streamed. Each time the SLI is played to the listener, the

listener perceives a matching localization experience. An example SLI or SLI file is altered or edited to adjust one or more properties of the localization in order to produce an adjusted localization (e.g., changing one or more SLP coordinates in the SLI, changing an included HRTF to a HRTF of a different listener, or
5 changing the sound that is designated for localized).

The SLI can be specific to a sound, such as a sound that is packaged together with the SLI, or the SLI can be applied to more than one sound, any sound, or without respect to a sound (e.g., an SLI that describes or provides an RIR
10 assignment to the sound). SLI can be included as part of a sound file (e.g., a file header), packaged together with sound data such as the sound data associated with the SLI, or the SLI can stand alone such as including a reference to a sound resource (e.g., link, uniform resource locator or URL, filename), or without reference to a sound. The SLI can be specific to a listener, such as including
15 HRTFs measured for a specific listener, or the SLI can be applied to the localization of sound to multiple listeners, any listener, or without respect to a listener. Sound localization information can be individualized, personal, or unique to a particular person (e.g., HRTFs obtained from microphones located in ears of a person). This information can also be generic or general (e.g., stock or generic
20 HRTFs, or ITDs that are applicable to several different people). Furthermore, sound localization information (including preparing the SLI as a file or stream that includes both the SLI and sound data) can be modeled or computer-generated.

Information that is part of the SLI can include but is not limited to, one or more of
25 localization information, impulse responses, measurements, sound data, reference coordinates, instructions for playing sound (e.g., rate, tempo, volume, etc.), and other information discussed herein. For example, localization information provides information to localize the sound during the duration or time when the sound plays to the listener. For instance, the SLI specifies a single
30 SLP or zone at which to localize the sound. As another example, the SLI includes a non-looping localization designation (e.g., a time-based SLP trajectory

in the form of a set of SLPs, points or equation(s) that define or describing a trajectory for the sound) equal to the duration of the sound. For example, impulse responses include, but are not limited to, impulse responses that are included in convolution of the sound (e.g., head related impulse responses (HRIRs), binaural room impulse responses (BRIRs)) and transfer functions to create binaural audial cues for localization (e.g., head related transfer functions (HRTFs), binaural room transfer functions (BRTFs)). Measurements include data and/or instructions that provide or instruct distance, angular, and other audial cues for localization (e.g., tables or functions for creating or adjusting a decay, volume, interaural time difference (ITD), interaural level difference (ILD) or interaural intensity difference (IID)). Sound data includes the sound to localize, particular impulse responses or particular other sounds such as captured sound. Reference coordinates include information such as reference volumes or intensities, localization references (such as a frame of reference for the specified localization (e.g., a listener's head, shoulders, waist, or another object or position away from the listener) and a designation of the origin in the frame of reference (e.g., the center of the head of the listener) and other references.

Sound localization information can be obtained from a storage location or memory, an electronic device (e.g., a server or portable electronic device), a software application (e.g., a software application transmitting or generating the sound to externally localize), sound captured at a user, a file, or another location. This information can also be captured and/or generated in real-time (e.g., while the listener listens to the binaural sound).

Block 130 states store information pertaining to the zone(s), SLP(s), and/or SLI.

The information discussed in connection with blocks 100, 110, and 120 is stored in memory (e.g., a portable electronic device (PED) or a server), transmitted (e.g., wirelessly transmitted over a network from one electronic device to another

electronic device), and/or processed (e.g., executed in an example embodiment with one or more processors).

Figure 2 is a method to select where to externally localize binaural sound to a listener based on information about the sound in accordance with an example embodiment.

Block 200 states obtain sound to externally localize to a user.

By way of example, the sound is obtained as being retrieved from storage or memory, transmitted and received over a wired or wireless connection, generated from a locally executing or remotely executing software application, or obtained from another source or location. As one example, a user clicks or activates a music file or link to music to play a song that is the sound to externally localize to the user. As another example, a user engages in a verbal exchange with a bot, intelligent user agent (IUA), intelligent personal assistant (IPA), or other software program via a natural language user interface; and the voice of this software application is the sound obtained to externally localize to the user. Other examples of obtaining this sound include, but are not limited to, receiving sound as a voice in a telephone call (e.g., a Voice over Internet Protocol (VoIP) call), receiving sound from a home appliance (e.g., a wireless warning or alert), generating sound from a virtual reality (VR) game executing on a wearable electronic device (WED) such as a head mounted display or HMD, retrieving a voice message stored in memory, playing or streaming music from the internet, etc.

The sound is obtained to externally localize to the user as binaural sound such that one or more SLPs for the sound occur away from the user. For example, the SLP can occur at a location in 3D space that is proximate to the user, near-field to the user, far-field to the user, in empty space with respect to the user, at a virtual object in a software game, or at a physical object near the user.

In an example embodiment, the sound that is obtained is mono sound (e.g., mono sound that is processed or convolved to binaural sound), stereo sound (e.g., stereo sound that is processed or convolved to binaural sound), or binaural
5 sound (e.g., binaural sound that is further processed or convolved with room impulse responses or RIRs, and/or with altered audial cues for one or more segments or parts of the sound).

Block 210 states determine information about the sound.

10

Information about the sound includes, but is not limited, to one or more of the following: a type of the sound, a source of the sound, a software application from which the sound originates or generates, a purpose of the sound, a file type or extension of the sound, a designation or assignment of the sound (e.g., the
15 sound is assigned to localize to a particular zone or SLP), user preferences about the sound, historical or previous SLPs or zones for the sound, commands or instructions on localization from a user or software application, a time of day or day of the week or month, an identification of a sender of the sound or properties of the sender (e.g., a relationship or social proximity to the user), an identification
20 of a recipient of the sound, a telephone number or caller identification in a telephone call, a geographical location of an origin of the sound or a receiver of the sound, a virtual location where the sound will be heard or where the sound was generated, a file format of the audio, a classification or type or source of the audio (e.g., a telephone call, a radio transmission, a television show, a game, a
25 movie, audio output from a software application, etc.), monophonic, stereo, or binaural, a filename, a storage location, a URL, a length or duration of the audio, a sampling rate, a bit resolution, a data rate, a compression scheme, an associated CODEC, a minimum, maximum, or average volume, amplitude, or loudness, a minimum, maximum, or average wavelength of the encoded sound,
30 a date when the audio was recorded, updated, or last played, a GPS location of where the audio was recorded or captured, an owner of the audio, permissions

attributed to the audio, a subject matter of the content of the audio, an identify of voices or sounds or speakers in the audio, music in the audio input, noise in the audio input, metadata about the audio, an IP address or International Mobile Subscriber Identity (IMSI) of the audio input, caller ID, an identity of the speech
5 segment and/or non-speech segment (e.g., voice, music, noise, background noise, silence, computer-generated sounds, IPA, IUA, natural sounds, a talking bot, etc.), and other information discussed herein.

By way of example, a type of sound includes, but is not limited to, speech, non-
10 speech, or a specific type of speech or non-speech, such as a human voice (e.g., a voice in a telephony communication), a computer voice or software generated voice (e.g., a voice from an IPA, a voice generated by a text-to-speech (TTS) process), animal sounds, music or a particular music, type or genre of music (e.g., rock, jazz, classical, etc.), silence, noise or background noise, an alert, a
15 warning, etc.

Sound can be processed to determine a type of sound. For example, speech activity detection (SAD) analyzes audio input for speech and non-speech regions of audio input. SAD can be a preprocessing step in diarization or other speech
20 technologies, such as speaker verification, speech recognition, voice recognition, speaker recognition, et al. Audio diarization can also segment, partition, or divide sound into non-speech audio and/or speech audio into segments.

In some example embodiments, sound processing is not required for sound type
25 identification because the sound is already identified, and the identification is accessible in order to consider in determining a localization for the sound. For example, the type of sound can be passed in an argument with the audio input or passed in header information with the audio input or audio source. The type of sound can also be determined by referencing information associated with the
30 audio input designated. A type of sound can also be determined from a source or software application (e.g., sound from an incoming telephone call is voice or

sound in a VR game is identified as originating from a particular character in the VR game). An example embodiment identifies a sound type of a sound by determining a sound ID for the sound and retrieving the sound type of a localization instance in the localization log that has a matching sound ID.

5

By way of example, a source of sound includes, but is not limited to, a telephone call or telephony connection or communication, a music file or an audio file, a hyperlink, URL, or proprietary pointer to a network or cloud location or resource (e.g., a website or internet server that provides music files or sound streams, a link or access instructions to a source of decentralized data such as a torrent or other peer-to-peer (P2P) resource), an electronic device, a security system, a medical device, a home entertainment system, a public entertainment system, a navigational software application, the internet, a radio transmission, a television show, a movie, audio output from a software application (including a VR software game), a voice message, an intelligent personal assistant (IPA) or intelligent user agent (IUA), and other sources of sound.

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Block 220 states select a sound localization point (SLP) and/or zone in which to localize the sound to the user based on the information about the sound.

20

The information about the sound indicates, provides, or assists in determining where to externally localize the binaural sound with respect to the user. Based on this information, the computer system, electronic system, software application, or electronic device determines where to localize the sound in space away from the user. This information also indicates, provides, or assists in determining what sound localization information (SLI) to select to process and/or convolve the sound so it localizes to the correct location and also includes the correct attributes, such as loudness, RIRs, sound effects, background noise, etc.

25

30

Consider an example in which an audio file or information about the sound includes or is transmitted with an identification, designation, preference, default,

or one or more specifications or requirements for the SLP and/or the zone. For example, this information is included in the packet, header, or forms part of the metadata. For instance, the information indicates a location with respect to the listener, coordinates in a coordinate system, HRTFs, a SLP, or a zone for where
5 the sound should or should not localize to the listener.

Consider an example embodiment in which a SLP and/or a zone is selected based on one or more of the following: information about sound stored in a memory (e.g., a table that includes an identification or location of a SLP and/or
10 zone for each software application that externally localizes binaural sound), information in an audio file, information about sound stored in user preferences (e.g., preferences of the user that indicate where the user prefers to externally localize a type of sound or sound from a particular software application), a command or instruction from the user (e.g., the listener provides a verbal
15 command that indicates the SLP), a recommendation or suggestion from another software program (e.g., an IUA or IPA of another user, who is not the listener, provides a recommendation based on where the other user selected to externally localize the sound), a collaborative decision (e.g., weighing recommendations for the SLP from multiple different users, including other listeners and/or software
20 programs), historical placements (e.g., SLPs or zones where the user previously localized the same or similar sound, or previously localized sound from a same or similar software application), a type of sound, an identity of the sound (e.g., an identified sound file, piece of music, voice identity), and an identification of the software application generating the sound or playing the sound to the user.

25

Block 230 states provide the sound to the user so the sound externally localizes as binaural sound to the user at the selected SLP and/or the selected zone.

The sound is processed and/or convolved so it externally localizes away from the
30 user at the selected SLP and/or selected zone, such as a SLP in 3D audio space away from a head of the user. In order for the user to hear the sound as

originating or emanating from an external location, the sound transmits through or is provided through a wearable electronic device or a portable electronic device. For example, the user wears electronic earphones in his or her ears, wears headphones, or wears an electronic device with earphones or headphones, such as an optical head mounted display (OHMD) or HMD with headphones. A user can also listen to the binaural sound through two spaced-apart speakers that process the sound to generate a sweet-spot of cross-talk cancellation.

Consider an example in which information about the sound provides that the sound is a Voice over Internet Protocol (VoIP) telephone call being received at a handheld portable electronic device (HPED), such as a smartphone. VoIP telephone calls are designated to one of SLP1, SLP2, SLP3, or SLP4. These SLPs are located in front of the face of the user about 1.0 meter away. The software application executing the VoIP calls selects SLP2 as the location for where to place the voice of the caller. The user is not surprised or startled when the voice of the caller externally localizes to the user since the user knows in advance that telephone calls localize directly in front of the face 1.0 meter away.

An example embodiment assigns unique sound identifications (sound IDs) to unique sounds in order to query the localization log to determine the sound type and/or sound source of a unique sound. Examples of unique sounds include but are not limited to the voice of a particular person or user (e.g., voices in a radio broadcast or a voice of a friend), the voice of an IPA, computer-generated voice, a TTS voice, voice samples, particular audio alerts (chimes, ringtones, warning sounds), particular sound effects, a particular piece of music. The example embodiment stores the sound IDs in the SLP table and/or localization log or database associated with the record of the localization instance. The localization record also includes the sound source or origins and sound type.

The example embodiment determines or obtains the unique sound identifier (sound ID) for a sound from or in the form of a voiceprint, voice-ID, voice

recognition service, or other unique voice identifier such as one produced by a voice recognition system. The example embodiment also determines or obtains the sound ID for the sound from or in the form of an acoustic fingerprint, sound signature, sound sample, a hash of a sound file, spectrographic model or image, acoustic watermark, or audio based Automatic Content Recognition (ACR). The example embodiment queries the localization log for localization instances with a matching sound ID in order to identify or assist to identify a sound type or sound source of the sound, and/or in order to identify a prior zone designation for the sound. For example, the sound ID of an incoming voice from an unknown caller matches a sound ID associated with the contact labeled as "Jeff" in the user's contact database. The match is a sufficient indication that the identity of the caller is Jeff. The SLP selector looks up the zone selected in a previous conversation with Jeff, and assigns a SLP in the zone to the sound.

The example embodiment allows the user or software application executing on the computer system to assign sound IDs to zones in order to segregate sounds with a matching sound ID with respect to one or more zones. For example, sounds matching one sound ID are assigned to localize in one zone and sounds matching another sound ID are prohibited from another zone.

20

Figure 3 is a method to store assignments of SLPs and/or zones in accordance with an example embodiment.

Block 300 states assign different SLPs and/or different zones to different sources of sound and/or to different types of sound.

An example embodiment assigns or designates a single SLP, multiple SLPs, a single zone, or multiple zones for one or more different sources of sound and/or different types of sound. These designations are retrievable in order to determine where to externally localize subsequent sources of sound and/or types of sound.

30

For example, each source of sound that externally localizes as binaural sound and/or each type of sound that externally localizes as binaural sound are assigned or designated to one or more SLPs and/or zones. Alternatively, one or more SLPs and/or zones are assigned or designated to each source of sound
5 that externally localizes as binaural sound and/or each type of sound that externally localizes as binaural sound.

Consider an example in which zone A includes five SLPs; zone B includes one SLP; and zone C includes thirty SLPs. Each zone is located between 1.0 m – 1.3
10 m away from a head of the listener. Zones A, B, and C are audibly distinct from each other such that a listener can distinguish or identify from which zone sound originates. For instance, the listener can distinguish that sound originates from zone A as opposed to originating from zones B or C, and such a distinction can be made for zones B and C as well. Telephony software applications are
15 assigned to zone A; a voice of an intelligent personal assistant (IPA) of the listener is assigned to zone B; and music and/or musical instruments are assigned to zone C. The listener can memorize or become familiar with these SLP and zone designations. As such, when a voice in a telephone call originates from the location around the head of the listener at zone A, the listener knows
20 that the voice belongs to a caller or person of a telephone call. Likewise, the listener expects the voice of the IPA to localize to zone B since this location is designated for the IPA. When the voice of the IPA speaks to the listener from the location in zone B, the listener is not startled or surprise and can determine that the voice is a computer-generated voice based on the voice localizing to the
25 known location.

The example above of zones A, B, and C further illustrates that zones can be separated such that sounds or software applications assigned to one zone are distinguishable from sounds or software applications assigned to another zone.
30 These designations assist the listener in organizing different sounds and software applications and reduces confusion that can occur when different

sounds from different software applications externally localize to varied locations, overlapping locations, or locations that are not known in advance to the listener.

Block 310 states store in memory the assignments of the different SLPs and/or
5 the different zones to the different sources of sound and/or the different types of sound.

The assignments or designations are stored in memory and retrieved to assist in
determining a location for where to externally localize binaural sound to the
10 listener.

Consider an example in which a user clicks or activates or an IPA selects playing
of an audio file, such as a file stored in MP3, MPEG-4 AAC (advanced audio
coding), WAV, or another format. The user or IPA designates the audio file to
15 play at an external location away from the user at a SLP with coordinates (1.1 m,
10°, 0°) without respect to head movement of the user. A digital signal processor
(DSP) convolves the audio file with HRTFs of the listener so the sound localizes
as binaural sound to the designated SLP. The audio file is updated with the
coordinates of the SLP and/or the HRTFs for these coordinates. The assignment
20 of the SLP is thus stored and associated with the audio file. Later, the user again
clicks or activates or the IPA selects the audio file to play. This time, however,
the assignment information is known and retrieved with or upon activation of the
audio file. The audio file plays to the user and immediately localizes to the SLP
with coordinates (1.1 m, 10°, 0°) since this assignment information was stored
25 (e.g., stored in a table, stored in memory, stored with or as part of the audio file,
etc.). When the audio file plays to the assigned location, the user is not surprised
when sound externally localizes to this SLP since the sound previously localized
to the same SLP.

30 In this example of the user or IPA playing the audio file, the user expects,
anticipates, or knows the location to where the audio file will localize since the

same audio file previously localized to the SLP with coordinates at (1.1 m, 10°, 0°). This process can also decrease processing execution time since an example embodiment knows the audio file sound localization information in advance and does not need to perform a query for the sound localization information. Also in
5 case of a query for the same information, this information is stored in a memory location to expedite processing (e.g., storing the information with or as part of the audio file, storing the information in cache memory, or a lookup table). The SLP and/or SLI can be prefetched or preprocessed to reduce process execution time and increase performance of the computer. In addition, in cases where the same
10 sound data (e.g., an alert sound) has been convolved previously with the same HRTF pair or to the same location relative to the user, the SLS plays the convolved file again from cache memory. Playing the cached file does not require convolution and so does not risk decreasing the performance of the computer system in re-executing the same convolution. This increases the performance of
15 the computer system with respect to other processes, such as another convolution.

Figure 4 shows a coordinate system 400 with zones or groups of SLPs 400A, 400B, 400C around a head 410 of a user 420. The figure shows an X-Y-Z
20 coordinate system to illustrate that the zones or groups of SLPs are located in 3D space away from the user. The SLPs are shown as small circles located in 3D areas that include different zones.

Three zones or groups of SLPs exist, but this number could be smaller (e.g., one
25 or two zones) or larger (four, five, six, ... ten, ... twenty, etc.). Zones or group of SLPs 400A, 400B, 400C include one or more SLPs.

A zone can also be, designate, or include a location where sound is prohibited from localizing to a user, or where a sound is not preferred to externally localize
30 to a user. Figure 4 shows an example of such a zone 430. This zone can have SLPs or be void of SLPs. By way of example, consider zones that prohibit

localization specified behind a user, below a user, in an area known as the cone of confusion of a listener, or another area with respect to the user. For illustration, zone 430 is shown with a dashed circle behind a head of the user, but a zone can have other shapes, sizes, and locations as discussed herein.

5

Consider an example in which the SLS compares the region defined as zone 430 with a region known to be the field-of-view of the user and determines that no part of zone 430 is within the field-of-view of the user. The user requires that external localizations must occur within his or her field-of-view. The SLS thus identifies zone 430 as prohibited for localization. When a software application requests an SLP or zone for a sound, the SLS does not provide zone 430 or a SLP included by zone 430. When a software application requests zone 430 or a SLP included by zone 430, the SLS denies the request.

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The SLS can designate a zone as limited or restricted for all localization, for some localization, or for certain software applications or sound sources. For example, the SLS of an automobile control system allows a binaural jazz music player application to select SLPs without reservation, but restricts a telephony application to SLPs that do not exist in a zone defined as outside the perimeter of the car interior. An incoming call requests to localize to the driver at a SLP four meters from the driver. The SLP at four meters is not in use and is permitted by the user preferences. The automobile control system, however, denies the telephony application from selecting the SLP four meters from the driver because the SLP lies in the zone prohibited to the application, being outside the perimeter of the interior of the car. So the SLS of the automobile control system assigns the incoming caller SLP to coordinates at a passenger seat.

20

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Consider an example in which a telephone application executes telephone calls, such as cellular calls and VoIP calls. When the telephony application initiates a telephone call or receives a telephone call, a voice of the caller or person being called externally localizes into a zone that is in 3D space about one meter away

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from a head of the user. The zone extends as a curved spherical surface with an azimuth (θ) being $330^\circ \leq \theta \leq 30^\circ$ and with an elevation (φ) being $340^\circ \leq \varphi \leq 20^\circ$. Areas in 3D space outside of this zone are restricted from localizing voices in telephone calls to the user. When the user receives a phone call with the telephony application, the user knows in advance that the voice of the caller will localize in this zone. The user will not be startled or surprised to hear the voice of the caller from this zone.

The SLS, software application, or user can designate or enforce a zone as available, restricted, limited, prohibited, designated for, or mandatory or required for localization of all, none, or selected applications or sound sources, and/or sound types, and/or specific or identified sounds or sound IDs. Consider an example in which a user has hundreds or thousands of SLPs in an area located between one meter and three meters away from his or her head. An audio or media player can localize music to any of these SLPs. The media player, for certain music files (e.g., certain songs), restricts or limits sound to localizing at specific SLPs or specific zones. For instance, song A (a rock-n-roll song) is limited to localizing vocals to zone 1 (an area located directly in front of a face of the listener), guitar to zone 2 (an area located about 10° - 20° to a right of zone 1), drums to zone 3 (an area located about 10° - 20° to a left of zone 1), and bass to zone 4 (an area located inside the head of the listener). Further, different instruments or sound can be assigned to different zones. For example, vocals or voice are assigned to localize inside a head of the listener, whereas bass, guitar, drums, and other instruments are assigned to distinct or separate zones. An audio segmenter creates segments for each instrument so that each segment localizes to a different zone. Alternatively, the music is delivered to the user in a multi-track format with the sound of each instrument on its own track. This delivery allows the media player, the SLS, or the user to assign each instrument track to a zone.

Restricted, limited, or prohibited SLPs and/or zones can be stored in memory and/or transmitted (e.g., as part of the sound localization information or information about the sound as discussed herein).

- 5 Placing sound into a designated zone or a designated SLP provides the listener with a consistent listening experience. Such placement further helps the listener to distinguish naturally occurring binaural sound (e.g., sounds occurring in his or her physical environment) from computer-generated binaural sound because the listener can restrict or assign computer-generated binaural sound to localize in
10 expected zones.

Consider an example of a HPED such as a digital audio player (DAP) or smartphone in which the SLS and/or SLP selector restrict localization of sound to a safe zone for one or more sound sources (e.g., any or all sound sources). For
15 example, if a SLP is requested that is not within the safe zone then the sound is adjusted to localize inside the safe zone, switched to localize internally to the user, not output, or output with a visual and/or audio warning. For example, the user understands or determines that the safe zone is the zone or area in his field-of-view (FOV). The user designates the area of his FOV and/or allows the
20 electronic system to determine or measure or calculate the FOV. For example, a software application executing on the HPED generates a test sound with a gradually varying ITD that begins at 0 ms and gradually becomes greater. The user experiences a localization of the sound starting at 0° azimuth and moving slowly to his or her left. The user listens for the moment when the gradually
25 panning test sound reaches a left limit of the safe zone, such as the point before which the sound seems to emanate from beyond the limit of his or her left side gaze (e.g., -60° to -100°). Then, at that moment, the user activates a control, issues a voice command, or otherwise makes an indication to the software application. At the time of the indication, the software application saves the ITD
30 value and assigns the value as a maximum ITD for binaural sound played to the user. Similarly, the software application uses different binaural cues or methods

to determine other limits of the safe zone (e.g., a minimum and maximum elevation, minimum and maximum distance, etc.). As another example, the user controls the azimuth, elevation, and distance of a SLP playing a test sound, such as by using a dragging action or knob or dial turning action or motion on a touch
5 screen or touch pad in order to move the SLP to designate the borders of the zone or safe zone.

The software application saves the safe zone limits to the HPED and/or the user's preferences. Alternatively, a default safe zone is included encoded in the
10 hardware, firmware, or write-protected software of the HPED. A software application that controls or manages sound localization for the HPED (such as the SLS and/or SLP selector) thereafter does not allow localization except inside the safe zone. The user can be confident that no software application will cause a sound localization outside of the area that he or she can confirm visually for a
15 corresponding event or lack of event in the physical environment. Consequently, the user is confident that sounds perceived by him or her outside the safe zone are sounds occurring in the physical environment, and this process improves the user functionality for default binaural sound designation.

20 As another level of localization safety, a safety switch on the HPED is set to activate a manual localization limiter. For example, a three-position hardware switch or software interface control has three positions (e.g., the switch appears on the display of a GUI of a HPED or HMD). The control is set to a "mono" position in order to output a single-channel or down-mixed sound to the user.
25 Alternatively, this switch is set to a position labeled "front" in order to limit localization to the safety zone, or the switch is set to a position called "360°" to allow binaural sound output that is not limited to a safety zone. In order to execute "front" or safe zone localization limitation, the SLS, firmware, or a DSP of the HPED monitors the ITD of the binaural signal as it is output from the sound
30 sources, operating system, or amplifier. For example, the SLS monitors binaural audial cues and observes a pattern of successive impulse patterns in the right

channel and matching impulse patterns in the left channel a few milliseconds (ms) later that have a slightly lower level or intensity. The differences in the left and right channels indicate to the SLS that the sound is binaural sound, and the SLS measures the ITD and/or ILD from the differences. The SLS compares the

5 ITD/ILD against a maximum ITD/ILD and/or otherwise calculates an azimuth angle of a SLP associated with the matching impulses. If or when the ITD/ILD exceeds a limit, the SLS, firmware, or DSP corrupts or degrades the signal or the binaural audial cues of the signal (e.g., the ITD is limited or clipped or zeroed) in order to prevent the perception of an externalized sound beyond the limit or

10 beyond an azimuth limit.

Consider an example in which the HPED is a WED (such as headphones or earphones), and the safety switch and SLS that monitors the audial cues are included in the headphones or earphones. The user of the WED couples the

15 headphones to an electronic device providing binaural sound, sets the switch to “front” and is confident that even if the coupled electronic device produces binaural sound, he or she will hear localization only in the safe zone.

Figure 5A shows a table 500A of example historical audio information that can be

20 stored for a user in accordance with an example embodiment.

The audio information in table 500A includes sound sources, sound types, and other information about sounds that were localized to the user with one or more electronic devices (e.g., sound localized to a user with a smartphone, HPED,

25 PED, or other electronic device). The column labeled Sound Source provides information about the source of the audio input (e.g., telephone call, internet, smartphone program, cloud memory (movies folder), satellite radio, or others shown in example embodiments). The column labeled Sound Type provides information on what type of sound was in the sound or sound segment (e.g.,

30 speech, music, both, and others). The column labeled ID provides information about the identity or identification of the voice or source of the audio input (e.g.,

Bob (human), advertisement, Hal (IPA), a movie (E.T.), a radio show (Howard Stern), or others as discussed in example embodiments. The column labeled SLP and/or Zone provides information on where the sounds were localized to the user. Each SLP (e.g., SLP2) has a different or separate localization point for the user. The column labeled Transfer Function or Impulse Response provides the transfer function or impulse response processed to convolve the sound. The column can also provide a reference or pointer to a record in another table that includes the transfer function or impulse response, and other information. The column labeled Date provides the timestamp that the user listened to the audio input (shown as a date for simplicity). The column labeled Duration provides the duration of time that the audio input was played to the user.

Example embodiments store other historical information about audio, such as the location of the user at the time of the playing of the sound, a position and orientation of the user at the time of the sound, and other information. An example embodiment stores one or more contexts of the user at the time of the sound (e.g., driving, sleeping, GPS location, software application providing or generating the binaural sound, in a VR environment, etc.). An example embodiment stores detailed information about the event that stopped the sound (e.g., end-of-file was reached, connection was interrupted, another sound was given priority, termination was requested, etc.). If termination is due to the prioritization of another sound, the identity and other information about the prioritized sound can be stored. If termination was due to a request, information about the request can be stored, such as the identity of the user, application, device, or process that requested the termination.

As one example, the second row of the table 500A shows that on January 1, 2016 (Date: 01/01/16) the user was on a telephone call (Sound Source: Telephone call) that included speech (Sound Type: Speech) with a person identified as Bob (Identification: Bob (human)) for 53 seconds (Duration 53 seconds). During this telephone call, the voice of Bob localized with a HRIR

(Transfer Function or Impulse Response: HRIR) of the user to SLP2 (SLP: SLP2). This information provides a telephone call log or localization log that is stored in memory and that the SLS and/or SLP selector consults to determine where to localize subsequent telephone calls. For example, when Bob calls again several days later, his voice is automatically localized to SLP2. After several localizations, the listener will be accustomed to having the voice of Bob localize to this location at SLP2.

Figure 5B shows a table 500B of example SLP and/or zone designations or assignments of a user for localizing different sound sources in accordance with an example embodiment.

By way of example and as shown in table 500B, both speech and non-speech for a sound source of a specific telephone number (+852 6343 0155) localize to SLP1 (1.0 m, 10°, 10°). When a person calls the user from this telephone number, sound in the telephone call localizes to SLP1.

Sounds from a VR game called "Battle for Mars" localize to zone 17 for speech (e.g., voices in the game) and SLP3 – SLP 5 for music in the game.

Consider an example wherein the zone 17 for the game is a ring-shape zone around the head of the user with a radius of 8 meters, and a zone 16 for voice calls is a smaller ring-shape zone around the head of the user with a radius of 2 meters. As such, the voices of the game in the outer zone 17 and the voices of the calls localized in the inner zone 16 localize from any direction to the user.

The user perceives the game sounds from zone 17 from a greater distance than the voice sounds from zone 16. The user is able to distinguish a game voice from a call voice because the call voices sound closer than the game voices.

The user speaks with friends whose voices are localized within zone 16, and also monitors the locations of characters in the game because he or she hears the game voices farther off. After some time, the user wishes to concentrate on the

game rather than the calls with his friends, so the user issues a single command to swap the zones. The swap command moves the SLPs of zone 16 to zone 17, and the SLPs of zone 17 to zone 16. Because the zones have similar shapes and orientations to the user, the SLP distances from the user changes, but the angular coordinates of the SLPs are preserved. After the swap, the user continues the game with the perception of the game voices closer to him, in zone 16. The user is able to continue to monitor and hear the voices of the calls from zone 17 farther off.

10 This example illustrates the advantage of using zones to segregate SLPs of different sound sources. Although the zones are different sizes, their like shapes allow SLPs to be mapped from one zone to the other zone at corresponding SLPs that the user can understand. This example embodiment improves functionality for the user who triggers the swap of multiple active SLPs with a

15 single command referring to two zones, without issuing multiple commands to move multiple phone call and game SLPs. The SLS that performs the swap recognizes the similar or like geometry of the zones. The SLS performs the multiple movements of the SLPs with a batch-update of the coordinates of the SLPs in a zone, and this accelerates and improves the execution of the

20 movement of multiple SLPs. The SLS reassigns a single coordinate (distance) rather than complete coordinates of the SLPs, and this reduces execution time of the moves. As a further savings in performance, because the adjustment of the distance coordinates is a single value (6 m), the SLS loads the value of the update register once, rather than multiple times, such as for each SLP in the

25 zones 16 and 17.

This table further shows that sounds from telephone calls from or to Charlie or telephone calls with Charlie internally localize to the user (shown as SLP6). Teleconference calls or multi-party calls localize to SLP20 – SLP23. Each

30 speaker identified in the call is assigned a different SLP (shown by way of example of assigning unique SLPs for up to four different speakers, though more

SLPs can be added). Calls to or from unknown parties or unknown telephone numbers localize internally and in mono.

All sounds from media players localize within zones 7 – 9.

5

Different sources of sound (shown as Sound Source) and different types of sound (shown as Sound Type) localize to different SLPs and/or different zones. These designations are provided to, known to, or available to the user.

10 Localization to these SLPs/zones provides the user with a consistent user experience and provides the user with the knowledge of where computer-generated binaural sound is or will localize with respect to the user.

15 Figure 5C shows a table 500C of example SLP and/or zone designations or assignments of a user for localizing miscellaneous sound sources in accordance with an example embodiment.

20 As shown in table 500C, audio files or audio input from BBC archives localizes at different SLPs. Speech in the segmented audio localizes to SLP30 – SLP35. Music segments (if included) localize to SLP40, and other sounds localize internally to the user.

25 As further shown in the table, YOUTUBE music videos localize to Zone 6 – Zone 19 for the user, and advertisements (speech and non-speech) localize internally. External localization of advertisements is blocked. For example, if an advertisement requests to play to the user at a SLP with external coordinates, the request is denied. The advertisement instead plays internally to the user, is muted, or not played since external coordinates are restricted, not available, or off-limits to advertisements. Sounds from appliances are divided into different SLPs for speech, non-speech (warnings and alerts), and non-speech (other). For
30 example, a voice message from an appliance localizes to SLP50 to the user, while a warning or alert (such as an alert from an oven indicating a cooking timer

event) localizes to SLP51. The table further shows that the user's intelligent personal assistant (named Hal) localizes to SLP60. An MP3 file (named "Stones") is music and is designated to localize at SLP99. All sound from a sound source of a website (Apple.com) localizes to Zone91.

5

The information stored in the tables and other information discussed herein assists a user, an electronic device, and/or a software program in making informed decisions on how to process sound (e.g., where to localize the sound, what transfer functions or impulse responses to provide to convolve the sounds, what volume to provide a sound, what priority to give a sound, when to give a sound exclusive priority, muting or pausing other sounds, such as during an emergency or urgent sound alert, or other decisions, such as executing one or more elements in methods discussed herein). Further, information in the tables is illustrative, and the tables include different or other information fields, such as other audio input or audio information or properties discussed herein.

10

15

Decisions on where to place sound are based on one or more factors, such as historical localization information from a database, user preferences from a database, preferences of other users, the type of sound, the source of the sound, the source of the software application generating or transmitting the sound, the duration of the sound, a size of space around the user, a position and orientation of a user within or with respect to the space, a location of user, a context of a user (such as driving a car, on public transportation, in a meeting, in a visually rendered space such as wearing VR goggles), historical information or previous SLPs (e.g., information shown in table 500A), conventions or industry standards, consistency of a user sound space, and other information discussed herein.

20

25

Consider an example in which each user, software application, or type of sound have a unique set of rules or preferences for where to localize different types of sound. When it is time to play a sound segment or audio file to the user, an example embodiment knows the type of sound (e.g., speech, music, chimes,

30

advertisement, etc.) or software application (e.g., media player, IPA, telephony software) and checks the SLP and/or zone assignments or designations in order to determine where to localize the sound segment or audio file for the user. This location for one user or software application can differ for another user or
5 software application since each user can have different or unique designations for SLPs and zones for different types of sound and sources of sound.

For example, Alice prefers to hear music localize inside her head, but Bob prefers to hear music externally localize at an azimuth position of +15°. Alice and
10 Bob in identical contexts and locations and presented with matching media player software playing matching concurrent audio streams can have different SLPs or zones designated for the sound by their SLP selectors. For instance, Bob's preferences indicate localizing sounds to a right side of his head, whereas Alice's preferences indicate localizing these sounds to a left side of her head.
15 Although Alice and Bob localize the sound differently, they both experience consistent personal localization since music localizes to their individually preferred zones.

Figure 6 is a method to select a SLP and/or zone for where to localize sound to a
20 user in accordance with an example embodiment.

Block 600 states obtain sound to externally localize as binaural sound to a user.

By way of example, the sound is obtained from memory, from a file, from a
25 software application, from microphones, from a wired or wireless transmission, or from another way or source (e.g., discussed in connection with block 200).

Block 610 makes a determination as to whether a SLP and/or zone is designated.

30 The determination includes analyzing information and properties of the sound (such as the source of the sound, type of the sound, identity of the sound, and

other sound localization information discussed herein), information and properties of the user (such as the user preferences, localization log, and other information discussed herein), other information about this instance and/or past instances of the localization request or similar requests, and other information.

5

If the answer to this question is “no” then flow proceeds to block 620 that states determine a SLP and/or a zone for the sound.

10 When the SLP and/or zone is not known or not designated, an electronic device, user, or software application determines where to localize the sound. In case the electronic device or software application cannot measure or calculate a best, preferred, desired, or optimal selection of a SLP or zone with a high degree of likelihood or probability, then some example actions that can be taken by the software application or electronic device include, but are not limited to, the
15 following: selecting a next or subsequent SLP or zone from an availability queue; randomly selecting a SLP or zone from those available to a user; querying a user (such as the listener or other user) to select a SLP or zone; querying a table, database, preferences, or other properties of a different remote or past user, software application or electronic device; and querying the IUA of other users as
20 discussed herein.

As another example, the software application or electronic device selects a default location. For example, when the SLP and/or zone is not known for an incoming sound, the software application or electronic device selects a
25 predetermined SLP and convolves the sound so it localizes to this predetermined or preset SLP. As another example, the software application providing the sound designates the default or preset SLP. For example, a VoIP chat application specifies a default planar zone defined by points with a -10° elevation, and within 15° of 0° azimuth, and within two meters of the user. As another example, a
30 device specifies a default SLP or zone (e.g., a WED specifies a default localization of “any point in a safe zone”). As another example, the file or media

to be played designates a SLP or zone. Consider an example of an audiobook that includes a header tag that specifies a default localization in spherical coordinates of (1.5 m, 0°, 12°) for the voice of the narrator.

- 5 As another example, the software application or electronic device analyzes previous or historical SLPs and/or zones for sound and selects one based on this analysis. For example, historical sound localization information provides sufficient information to predict a zone that the user will find satisfying, logical, informative, expected, familiar, seamless, unobtrusive, or otherwise appropriate.

10

As another example, the software application or electronic device determines the location based on collaboration or recommendations from user agents, IUAs, IPAs, or other software applications. For example, example embodiments include methods to select a SLP and/or zone based on collaborative learning or

- 15 information exchange between user agents, such as different user agents of the user, and/or information exchange between user agents of other users.

As another example, the software application or electronic device asks the user where to localize the sound. For example, a natural language user interface
20 generates speech that asks a user, "Where do you want to place the sound?" and interprets vocal responses from the user such as, "to the left of the screen," "between Alice and Bob," "behind me," "far in the back," etc.

- 25 If the answer to this determination is "yes" then flow proceeds to block 630 that states select a SLP and/or sound localization information according to the designation.

When the designation is known, the software application or electronic device selects the SLP and/or zone according to the designation or assignment.

- 30 Examples of the SLP and/or zone being known or designated include, but are not limited to, being designated or provided by the software application (e.g., the

software application generating or providing the sound), provided by or with a file (e.g., provided in or with an audio recording), provided based on a type of sound (e.g., localizing voice to one SLP, localizing music to another SLP, localizing alarms to yet another SLP, etc.), provided by a user (e.g., a voice command or
5 gesture command specifies the SLP and/or zone), provided by a third party (e.g., a user transmitting the sound designates where to localize the sound), provided by an IPA or IUA (e.g., an IPA selects where to localize the sound for the user), provided from memory (e.g., the SLP and/or zone is retrieved from a lookup table or cache), provided by an electronic device (e.g., provided by a robot or avatar),
10 provided with another method or apparatus discussed herein, or provided with a known designation (e.g., provided with a specific SLP, zone, HRTFs, identification, etc.).

Block 640 states provide the sound to the user as binaural sound that externally
15 localizes in the 3D space away from the user.

The SLS or SLP selector retrieves sound localization information corresponding to the selected SLP or zone. For example, the SLP selector provides a zone identification of a selected zone to the SLS. The SLS scans a SLP table for a first
20 available SLP of, included in, or matching the zone, and retrieves an HRTF pair corresponding to coordinates of the SLP. The SLS convolves the sound with the HRTF pair and provides the sound to the user. By way of example, earphones, headphones, speakers with crosstalk cancellation, or a wearable electronic device with speakers in or at both ears of the user provide the sound to the user
25 as the binaural sound. Alternatively, a WED worn by the user includes positional head tracking (PHT) sensors, and the SLS retrieves the PHT data in order to compensate for the position and orientation of the head of the user in the selection of the HRTF pair that the SLS retrieves for convolution.

30 In an example embodiment, zones indicate a social or business relationship between a source of the sound and the user. For example, voices of family and

friends localize in one zone; voices of business associates localize in another zone; and voices of strangers localize in another zone. This type of localization improves the functionality of binaural communication since the user aurally perceives the relationship with the voice or sound based on where in 3D space the sound localizes with respect to the user.

Consider an example in which a SLS determines a new sound that generates from a telephony application executing on an HPED of a user. The SLS retrieves an identity of the sound or sound ID and passes the sound ID and the sound source (the telephony application) to the SLP selector with a request for a SLP for the sound. The SLP selector examines the sound ID, queries a contact list of the user with the sound ID (such as the telephone number) and finds a matching contact record. The contact record designates a family member of the user. The SLP selector queries the SLP table for a zone designated to family members and finds a matching zone tagged "family." The SLP selector selects an available SLP that is included in the family zone and assigns the incoming voice localization to the SLP. The SLP selector returns the SLP selection for the sound to the SLS and stores the localization instance (e.g., the SLP, sound source, sound type, timestamp, and other information) to the localization log. The SLS determines HRTFs for the selected SLP and passes the sound (the voice) and the HRTFs to a DSP that convolves the sound. The user hears the voice of the family member localized in the family zone.

In an example embodiment, zones indicate a phone call disposition or state of connection with other callers on a telephone call. For example, a caller on hold, a caller that has placed the user on hold, or an inactive caller (e.g., a caller who has not spoken or transmitted sound in the last three minutes) localize to a hold zone, such as a zone located above the head of the user or farther from the user.

Consider an example where the SLS monitors the sound of a connected caller and determines that the caller has been quiet for over three minutes.

Alternatively, the SLS determines that the same sound (such as hold music) has been playing for one minute. The SLS passes the sound source (a phone application) and the new state of the call (quiet) to the SLP selector with a request for the SLP to re-evaluate the SLP for the sound given the updated state
5 of the sound or call (quiet). The SLP selector queries the SLP table for a zone designated to the sound source and to the new state (quiet). The SLP selector selects a SLP that is included in the quiet zone and available, updates the coordinates of the SLP of the caller, and notifies the SLS and/or DSP of the update. The SLS determines HRTFs for the updated SLP coordinates and
10 passes the new HRTFs to the DSP. The DSP continues to convolve the sound, now with the updated HRTFs, and the user hears the quiet sound or hold music of the call in the quiet zone.

Consider an example where the SLP selector receives a SLP request for an
15 incoming sound but the sound type and sound source of the request are unknown, not supplied, or not determinable. The SLP selector has no basis to select a SLP or zone, so the SLP selector examines the SLP table to determine a region that does not include SLPs, defines a zone for the region, and creates a SLP in the zone. The SLP selector notifies the SLS of the approved and active
20 status of the SLP record. The notification triggers the SLS to commence the localization of the sound according to the new SLP. The user hears the sound localized in the newly defined zone.

In an example embodiment, sound sources do not request the SLP selector to
25 assign a SLP or zone, but instead submit SLP or HRTF coordinates to the SLP selector for approval. The sound sources execute as sound objects that independently determine their localization and/or execute their own convolution. The sound objects or sound sources request localization approval as part of their operation. For example, sound source objects execute with a game application
30 on the HPED and submit requested or default SLPs that the sound objects attempt to localize to the user. In this example, the sound objects or sound

sources communicate to the SLP selector and not through the SLS. The SLP selector, based on the received sound source and coordinates, evaluates the requested coordinates prior to or during the localization of the sound and approves or denies the request, or returns alternative coordinates such as

5 proximate to the coordinates or in an allowed zone for the sound source and/or sound type. In the case of a denial, if the sound is already localizing, the SLP selector directs the sound object or SLS to halt localization of the sound. In the latter case, the SLS triggers the DSP or processor to halt convolution of the sound source or sound object.

10

Consider an example where the game application generates a sound object and the sound object assigns HRTF or SLP coordinates to the sound it supplies. The sound object and/or game application sends the coordinates, the identity of the sound, and source of the sound (the identity of the game application and/or

15 sound object) to the SLP selector. The SLP selector examines the identity and source of the sound and queries the SLP table for active SLPs at or near the requested SLP. Finding the coordinates available, the SLP selector further queries the SLP table for zones that include the SLP. The SLP selector evaluates each zone to determine that such a sound type and sound source are

20 allowed to localize to the zone according to the rules designated to the zones. If no zone prohibits localizations of the sound object or the application (the game), or the sound type, then the SLP selector responds to the request from the sound object with an approval of the SLP request. The SLP selector creates or updates a SLP record for the sound and notifies the SLS of the approved and active

25 status of the SLP record. The notification triggers the sound object to commence its localization or the SLS to direct the convolution of the sound according the approved SLP. The user hears the game sound at the spot requested by the sound object.

30 A problem can occur when an electronic device, software application, or user designates a zone or SLP for external sound localization but this zone or SLP is

not available or appropriate for a location to localize binaural sound. For example, a user or a software application designates a particular location where sound will localize to a listener while another software application is already localizing sound to this location. As another example, a physical obstruction (e.g., a wall or a person) exists at the location that prevents the visual experience from matching the auditory experience of the user (e.g., two sounds coming from one point or an unfitting reverberation or attenuation). As another example, the location poses a hazard or danger to the user if binaural sound localizes to this area (e.g., localizing binaural sound behind or in a blind spot of a user while the user drives an automobile).

Example embodiments solve these problems and others and resolves conflicts that occur with respect to designations of a SLP or zone.

Figure 7 is a method to resolve a conflict with a designation of a SLP and/or zone in accordance with an example embodiment.

Block 700 states provide a designated location where binaural sound will externally localize to a user.

20

A software application, electronic device, or a user provides a SLP, a zone, HRTFs, coordinates, sound localization information, or other information that designates a location where binaural sound will externally localize to the user.

This location can be a preferred or desired location. For example, a caller

25 telephones a user, and the caller (or the software application executing the telephone call) provides a desired location where the voice of the caller should localize with respect to the user. As another example, a user clicks or activates a music file to play a song, and the music file or media player executing the music file includes a default location (e.g., the default location is specified by an SLI component included in the music file) where the song will externally localize to the listener. As another example, a voice personal assistant (VPA) speaks

30

through earphones to a user and automatically attempts to have its voice localize to a particular SLP away from the user. As another example, a VR software program provides binaural sound to localize at designated locations to a user while the user wears a head mounted display and plays a VR game associated
5 with the software program.

Block 710 states transmit and/or store the designated location where the binaural sound will localize to the user.

10 The designated location can be stored in memory, stored in a file such as a SLI file, and/or transmitted (e.g., wirelessly transmitted over one or more networks). The designated location can be stored and/or transmitted with the sound, or stored and/or transmitted separately from the sound. For example, a sound file includes the designated location, and these two items are transmitted together
15 over the internet. As another example, the sound file is transmitted without the designated location, but the designated location is stored at or generated by an electronic device or software program receiving the sound file. As another example, the designated location is transmitted, without the sound, to a server, a handheld portable electronic device (HPED), portable electronic device (PED), or
20 wearable electronic device (WED) that stores or generates the sound upon receiving the designated location.

Consider an example in which the SLP, zone, and/or SLI (e.g., HRTFs, ILD, and/or ITDs, and/or localization instructions) are wirelessly transmitted along with
25 or together with the sound that will be played to the user and localize as binaural sound in 3D space away from the user. This information can be transmitted at a same time as the sound in a same file or same stream as the sound or in a separate file as the sound. For example, the information is sent together or along with the sound. As another example, the SLI file includes the sound data, or the
30 sound data includes the SLI. As yet another example, the localization data is encoded with the sound data. Alternatively, this information can be transmitted

separately from the sound, at a different time than the sound, or with different packets than the sound or over a different network connection or session.

Block 720 states obtain the designated location and the sound to externally
5 localize to the user.

The designated location or locations (e.g., a set or series of SLPs or a description of a path followed by the SLP over time) and/or sound is retrieved or received by an application executing in the electronic system from a location in
10 memory, a file, a transmission, or a capture (of the sound). Further, the designated location and/or sound can be generated or produced (e.g., generated in real time upon execution of a software program). For example, the software application or another process executing in the electronic system creates a sound rendered by the application (e.g., a TTS sound), specifies a localization,
15 and assembles a SLI file. The SLI file includes the description of the specified localization packaged together with the sound. As another example, during a telephone call with a caller, a user provides voice commands to designate locations. A natural language user interface interprets the voice commands as location or zone descriptions around the head of the user. The SLS designates
20 zones from the zone descriptions, receives the voice of the caller from a telephone application, and moves the voice of the caller to the zones located around the head of the user.

Block 730 makes a determination as to whether a conflict exists with the
25 designated location where the binaural sound will localize to the user.

Examples of a conflict include, but are not limited to, one or more of the following: another sound is already localizing at the designated location, a virtual microphone point (VMP) is designated at the location, another sound is
30 scheduled or planned to localize at the designated location, a physical or virtual object obstructs or exists at the designated location, there is another pending

request to localize binaural sound to the designated location, a property or permission restricts or prohibits localizing external sound to the user (such as a property of the designated location, physical environment, sound source, application, device, or user), HRTFs or other sound localization information or resources cannot be obtained or are not available to convolve sound to the designated location, the user or a software application has previously instructed or commanded that binaural sound not localize to the designated location, the user or a software application instructs or commands that binaural sound localizes to a location that is different than the designated location, localizing the sound to the designated location has, is, or would consume or exceed available, allotted, or recommended bandwidth or processing power, the designated location is different than a location recommended by a software application (e.g., IPAs or IUAs), another sound is not localizing at the designated location but is localizing to a nearby SLP and the listener would not be able to audibly distinguish between the SLP and a SLP at the designated location, or other conflicts.

If the answer to this question is “no” flow proceeds to block 740 that states provide the binaural sound to the user so the binaural sound externally localizes at the designated location.

For example, a digital signal processor (DSP) or other processor convolves and/or processes the sound so it externally localizes as binaural sound away from the user to the designated location that is in 3D space.

If the answer to this question is “yes” flow proceeds to block 750 that states take an action.

Execution of the action resolves the conflict, renders the conflict moot, alters the conflict, delays the conflict, avoids the conflict, proceeds in spite of the conflict, or produces another result. By way of further example, such actions include, but are

not limited to, the following: moving the designated location to another SLP and/or zone (e.g., altering an azimuth angle (θ) of the SLP, an elevation angle (φ) of the SLP, and/or a distance (r) of the SLP from the user), switching or changing the sound to another form of sound (e.g., providing the sound to the user in mono sound or stereo sound instead of binaural sound), delaying execution of the sound until the conflict is resolved (e.g., waiting a period of time until the conflict no longer exists), informing the user of the conflict (e.g., providing the user with an audio warning, an audio alert, an audio notification, a visual warning, a visual alert, a visual notification, etc.), altering the sound to the user (e.g., increasing a volume of the sound, decreasing a volume of the sound), stopping or preventing the sound from localizing to the user, augmenting the sound (e.g., convolve a RIR with the sound, add background noise to the sound, add music to the sound, etc.), or taking another action.

15 When a conflict occurs, the user, electronic device, and/or software application is informed about the conflict and how it was resolved or not. Further, this information is stored in memory, such as the localization log. The SLP selector or other process with permission to access the storage retrieves and analyzes the instances of conflicted, failed, or changed zone or SLP requests in order to assist

20 in resolving a subsequent conflict that occurs at a later time in the future. For example, facts surrounding a conflict and the resolution to the conflict are stored in the localization log. When a subsequent conflict occurs in a same zone and/or with a same sound source, the SLP selector searches the log for failed localizations with a matching zone or sound source or other similarity with the

25 current conflict. The SLP selector analyzes the localization records returned by the searches to determine a resolution to the current conflict. Consulting previous conflicts or failed or delayed localization or zone requests and the resolution or recorded final state of the requests improves performance of the computer executing the binaural sound. For instance, this consulting improves the delivery

30 time of zone or localization requests by preventing re-execution of conflict resolution processes. Binaural sound convolved to conflicting locations that is

extraneous, unnecessary, unappreciated, or interrupting does not improve user experience and so the convolution or processing that produces the sound is wasted, and slows important convolution or processes that share resources. Reducing this waste improves computer performance. In addition, multiple

5 sounds convolved to a same SLP can result in a user failing to localize the sounds due to mixed audial cues. Reducing this destructive localization improves functionality of the computer or computer system executing the binaural sound. Example embodiments reduce the time required to halt the tax on resources of such processes. Reducing the time further improves the performance and

10 functionality gains of eliminating the destructive localization.

Consider an example in which an electronic device of a user stores restrictions (including rules, or priorities) for where binaural sound externally localizes to the user in 3D space. The restrictions govern SLPs and zones for different types of

15 sound, different software applications that generate or produce the sound, different sources of the sound, different times of day when the sound is played or requested to be played, different users sending the sound, etc. Before binaural sound is played to the user, the software program executing the binaural sound consults the restrictions to determine if a conflict exists. For example, a

20 determination is made as to whether a proposed SLP or zone for where the binaural sound is intended or is programmed to localize with respect to the user conflicts with one or more of the restrictions. When the electronic device or software application detects a conflict, it executes an action to resolve or avoid the conflict.

25 Consider an example in which a person sends a voice message to a user and requests that the voice message localizes to zone 1 of the user that is located at (1.0 m, 10°, 0°). This location (i.e., zone 1) transmits with and/or is tagged or attached to the audio file. This location, however, produces an audio conflict

30 since the user is listening to music that externally localizes to this location when the voice message is received. A smartphone of the user changes the

coordinates of the voice message localization to zone 2 at (1.0 m, 330°, 20°), convolves the voice message with HRTFs corresponding to these coordinates, and plays the voice message to the user. The new location at zone 2 is available for sound localization since no music or other sounds were being convolved and
5 localized to this zone.

Consider an example in which an advertiser records an audio advertisement in binaural sound so the advertisement plays and localizes to a user in an area located in front of a face of the user. In accordance with a local regulation, the
10 advertiser must also make available the HRIRs convolved with the advertisement audio. This location, however, conflicts with audio preferences of the user that provide advertisements cannot externally localize to the user but must be provided in stereo sound or mono sound to the user. A wearable electronic device (WED) of the user discovers this conflict before the advertisement plays to
15 the user through earphones. In response to this conflict, the WED processes or deconvolves the advertisement audio from the HRIRs made available so the advertisement audio plays without localization to the user through the earphones and hence does not violate the user preferences regarding audio advertisement localization.

20 One or more example embodiments increase or improve performance of a computer, an electronic device, or computer system executing an example embodiment. One or more example embodiments also improve the ability to execute instructions and/or increase a speed to execute instructions that provide
25 binaural sound to localize to one or more SLPs that are external to a head or body of the listener.

Convolving or processing sound in real time for multiple SLPs or SLPs that move with respect to the face of the user (such as when a convolution is subject to
30 adjustment according to head-tracking) is process intensive when the user and/or

the SLP is moving. A large number of process executions are required, and the vastness of these executions slow or hinder sound localization to the user.

- An example embodiment employs one or more of several techniques to solve this problem and improve execution performance of a computer. Example embodiments further include various solutions to increase performance of a computer, electronic device, and/or computer system executing binaural sound with example embodiments.
- 10 As one example, some types of sound or sources of sound are processed with servers in a network while the sound is in transit from a source electronic device to the electronic device of a user. Servers (such as those in a cloud or network) offer faster processing or convolving of sound than local processors (e.g., a processor on a HPED or PED). For instance, for some sources of sound (e.g.,
- 15 telephone calls), the voice of the caller originates from the electronic device of the caller, transmits across one or more networks (e.g., the Internet), and arrives at the electronic device of the user. The electronic device of the user processes and convolves the voice of the caller with HRTFs of the user (or other sound localization information) and provides the binaural sound to the user. This
- 20 process, however, can be expedited or processing resources conserved or limited at the electronic device of the user. Specifically, as the voice of the caller transmits across the network, servers process and/or convolve the sound with the HRTFs of the user (or other sound localization information) to zones pre-designated by the user, and provide the binaural sound to the electronic device
- 25 of the user already including binaural cues that localize to the zone. One or more faster processors of the network or cloud servers convolve the voice after it leaves the electronic device of the caller but before it arrives to the electronic device of the user. The electronic device of the user saves processing resources.
- 30 As another example, sound automatically switches from binaural to mono or stereo and from mono or stereo to binaural sound based on head orientations of

the user. For example, when a user tilts his or her head beyond a predetermined elevation angle or azimuth angle, the SLS takes an action, such as automatically internalizing the sound to the user or maintaining the SLP at a consistent point relative to the face of the user. For instance, the SLS decides not to move the SLP farther than the predetermined elevation or azimuth angle or ceases to adjust the SLP location for head orientation. These actions reduce processing and/or convolution of the sound.

Similarly, the SLS of an example embodiment refers to zones defined by a user, application, or device to halt convolution of SLPs that move outside of the zones, and this conserves and/or improves allocation of processing in agreement with the user thereby improving the experience of the user.

As another example, when a predetermined number of SLPs are already being convolved or when a predetermined level of processor activity is reached, the SLS takes an action to limit further processing or convolution to reduce process execution. For example, when this level is reached, the SLS ceases or stops processing or convolving of additional SLPs, or SLPs in a zone designated as a low priority zone.

20

As another example, when a number of SLPs are exceeded, the SLS changes or adjusts a localization priority for certain SLPs or zones, triggering adjustments as to the localization priority or sound quality of sounds or zones. For example, a zone 1 has a high localization priority and SLPs of zone 1 are convolved with the convolver (e.g., a processor or DSP). A zone 2 has a medium localization priority and SLPs of zone 2 are convolved with the convolver when the convolver resources allow, and otherwise are processed for spatialization by adjustment of ITD. A zone 3 has a low localization priority and SLPs of zone 3 are convolved with the convolver when the convolver resources allow, and otherwise are provided to the user in their native spatialization without adjustment. When a number of SLPs in zone 1 are exceeded, the SLS changes the localization

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priority of zone 2 to a low priority and this triggers a change in processing allocation to zone 1 and zone 2, and performance improvement for binaural sound processing of the SLPs in zone 1.

- 5 Consider an example in which the user designates particular zones for which audio quality is prioritized over spatiality or localization accuracy or quality, and other zones in which accurate localization is prioritized over audio quality.

As another example, electronic devices (such as HPEDs, WEDs, or PEDs) of
10 users share responsibility of convolving sound or convolve sound that plays at electronic devices of other users. For example, Alice and Bob talk to each other during a VoIP telephone call. The electronic device of Alice convolves the voice of Bob with her HRTFs and provides this voice as binaural sound that externally localizes to Alice to zone 1 at the front-left of Alice. The electronic device of Alice
15 also convolves the outbound voice of Alice with the HRTFs of Bob, and transmits her convolved voice to the electronic device of Bob that in turn provides her voice to Bob as binaural sound that externally localizes to Bob. The electronic device of Alice thus performs processing tasks for Bob as opposed to the electronic device of Bob performing these processing tasks for Bob, and this processing improves
20 the performance of the device of Bob for execution of Bob's other tasks.

In the example above, the device of Alice convolves her voice to a zone of Bob that Bob designated by prearrangement. Alternatively, Alice selects the zone of Bob from which Bob will localize the voice of Alice. In both cases, Alice and/or
25 Bob are required to complete and confirm the task of making the zone or SLP designation, and this task is bothersome or interruptive to their objective of a mutually binaural conversation. An example embodiment performs tasks of making the selection of the zone of Bob for the voice of Alice and eliminates the need for the participation of Alice and Bob. This process simplifies the
30 establishment of the mutual binaural conversation for Alice and/or Bob and improves the functionality of binaural telephony. For example, the SLP selector

makes an intelligent selection based on the localization of the voice of Bob to Alice. For example, the zone 1 at the left-front of Alice is already designated for the localization of the voice of Bob. The SLP selector refers to the localization table to find the coordinates of the voice of Bob relative to Alice and finds that the

5 coordinates are in the zone 1 at the left-front of Alice. With this information, the SLP selector calculates the coordinates of the head of Alice relative to the coordinates of the voice of Bob. The SLP selector assigns these calculated coordinates to the localization of the voice of Alice to Bob. As the voice of Bob localizes to the front-left zone of Alice, the SLP selector sets the coordinates for

10 the voice of Alice for Bob to the calculated coordinates (in this case at the front-left zone of Bob). Bob and Alice experience and understand their complementary positions relative to each other, matching the positional experience of a face-to-face conversation. Carrying out the conversation in a mutually understood face-to-face orientation improves the functionality of their binaural phone conversation.

15 Further, neither Alice nor Bob is prompted or interrupted in the establishment of their conversation owing to the improved functionality that makes such a prompt unnecessary.

In another example embodiment, the SLS predicts SLP movement (e.g., when a user moves his head) and pre-convolves sounds to the predicted SLPs during

20 times of low processor activity. If or when sound is requested at the SLPs, then delivery of the sound is expedited due to the pre-convolution. Localization zones improve performance of pre-convolution. For example, based on recent activity, a predictor indicates that a repeating beep sound at a SLP in a zone 1 will move a

25 distance d within half a meter ($0m < d < 0.5m$), in an unknown direction. The predictor submits tasks to convolve the sound in the multiple directions at the multiple points 0.5m or less from the SLP. As the direction is unknown, the task includes convolution for multiple points in a sphere with a 1m diameter. However,

30 the SLP in zone 1 lies on the edge of zone 1 and according to a rule is not permitted to move outside of zone 1. When the SLS receives the convolution tasks specifying coordinates outside of zone 1, the convolution is not performed

(due to the rule) and the SLS evaluates a next task. A 50% reduction in convolution is gained in this example where pre-convolution processing is limited to the intersection of predicted points and points of the zone 1 that confine the SLP. Reducing the background pre-convolution activity increases the performance of the foreground real-time binaural sound processing.

The use of zones of localization improves functionality in other ways. Consider an example wherein the user designates common labels to zones (e.g., “business,” “personal,” etc.) such as designating as “alerts” a zone 1 of forward-looking elevation angles between 45° and 75°. The SLP selector receives a zone request for an incoming call alert. A telephone application sending the zone request follows a convention of specifying the alert zone by the label “alerts” instead of specifying coordinates. The SLP selector, receiving the request, searches the localization table and finds that the user has a zone 1 labeled as “alerts” and so limits the selection of a SLP for the alert to available SLPs included in the zone 1. This example illustrates the following user functionality improvements. The user hears the alert in an expected zone. The user was not required to configure a localization for the alert in or for the telephone application or other applications. In spite of some of the SLPs in the zone 1 being in use, the zone 1 has additional SLPs that are available, avoiding an SLP conflict, and avoiding prompting or involving the user. Further, allowing the provision of labels or tags or categories to zones improves interoperability between software applications and/or users (e.g., the phone application of the user and the phone application of the caller) and thereby improves overall performance of binaural telephony for multiple users and software applications. In addition, since the number of SLPs in a zone is limited, for a zone designated to play sounds that have been localized in the zone before (such as alerts), pre-convolution of the sounds is effective, as well as caching convolutions for the localizations that are frequent. Allowing the provision of labels or tags or categories to zones improves the performance of pre-convolution and eliminates some pre-convolution altogether when the localizations are cached.

Figure 8 is a method to execute an action to increase or improve performance of a computer providing binaural sound to externally localize to a user in accordance with an example embodiment.

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Block 800 states take an action to increase or improve performance of a computer providing binaural sound to externally localize to a user.

10 The computer includes electronic devices such as a computer system or electronic system, wearable electronic devices, servers, portable electronic devices, handheld portable electronic devices, and hardware (e.g., a processor, processing unit, digital signal processor, controller, memory, etc.).

Example actions include, but are not limited to, one or more of the following:

15 storing HRTFs and/or other SLI in cache memory, local memory, or other memory or registers near or close to the processor (e.g., a DSP) executing an example embodiment, mapping and storing coordinates and/or locations of SLPs and/or zones of users so this coordinate information is known in advance (e.g., before sound for a requesting software application convolves to a SLP or zone),
20 storing coordinates and/or locations of SLPs and/or zones in cache memory, local memory, or other memory near or close to the processor (e.g., a DSP) executing an example embodiment, prefetching HRTFs and/or SLI, prefetching coordinates and/or locations of SLPs and/or zones of users, storing HRTFs and/or SLI in a lookup table, storing HRTFs and/or SLI with or as part of an audio
25 file, wirelessly transmitting the HRTFs, SLI, SLPs, and/or zones with or as part of the audio file, predicting where a user will externally localize sound and prefetching or preprocessing HRTFs and/or SLI and coordinates of SLPs and/or zones in response this prediction, configuring specialized or customized hardware to execute one or more of these actions (e.g., configuring logic gates or
30 logic blocks in a FPGA to executes blocks in figures, as opposed to executing software instructions in a processor to execute the blocks in the figures), and

taking other actions discussed herein (e.g., with respect to hardware such as the DSP, cache memory, and prefetcher).

Block 810 states execute the action to increase or improve performance of the
5 computer providing the binaural sound that externally localizes to the user.

The action can be executed with software and/or one or more hardware elements, such as a processor, controller, processing unit, digital signal processor, and other hardware (e.g., FPGAs, ASICs, etc.).

10

As one example, the external location where to localize the sound and/or the SLI are included with the audio file (e.g., in the header, one or more packets being transmitted or received, metadata, or other data or information). This situation reduces processing execution time or processing cycles (e.g., DSP execution
15 times and/or cycles) since the localization information and/or SLI is included with the sound.

Consider an example in which a telephony software application provides users with video chat and voice call services, such as telephone calls or electronic calls.

20 When an electronic device (e.g., a smartphone) of a user receives an incoming call, the call includes coordinate locations where the voice of the caller should localize to the user receiving the call. Furthermore, the incoming call also includes SLI or information to convolve the sound (e.g., HRTFs, ILDs, ITDs). The smartphone simultaneously receives the incoming call and localization
25 information. The smartphone is not required to execute processing steps in determining locations of SLI resources, establishing connections to the resources, and retrieving the SLI data to determine how to convolve the sound. The smartphone is also not required to execute processing to determine where to externally localize the call in binaural sound to the user since the coordinates for
30 the location and/or the SLI are provided together with or included in the sound and/or video data. Further, instead of providing this information as coordinates,

the incoming call includes the indication of the location as a zone or SLP such as a label or name or description.

Consider an example of a telephone call in which the electronic device or software application executing the call transmits a call along with one or more of the following: SLPs and/or zones where the caller will localize the voice of the other party or parties to the call, the SLPs and/or zones where the other party or parties to the call will localize the voice of the caller, SLI (e.g., HRTFs, ITDs, and/or ILDs) in order to externally localize the voice of the caller as binaural sound to the party or parties, and SLI (e.g., HRTFs, ITDs, and/or ILDs) in order to externally localize the voice of the party or parties as binaural sound to the caller. Transmission of this information assists in speeding up execution of the telephone call but also provides an information exchange so the electronic devices and/or software programs of the call have shared information on coordinate locations of voices and convolving instructions in the form of SLI. This information, for example, assists in expediting execution of telephone calls in which participants see each other in VR rooms or VR environments.

As another example, the sound or sound file includes sound localization information (SLI) as discussed herein. For example, information being transmitted with the sound includes the sound localization information needed to process or convolve the sound into binaural sound so the binaural sound externally localizes to the listener. For instance, the sound is transmitted with or includes the localization coordinates or zones, and HRTFs, ILDs, and/or ITDs for convolving or processing the sound. This situation reduces processing execution time (e.g., DSP execution times) since SLI for processing and/or convolving the sound is included with the sound (e.g., included with the file or stream header or the beginning of the file, included with handshake or initial transmission of the sound file or audio file/stream/data).

30

Consider an example in which a music audio file stores or includes SLI. When a user downloads, streams, clicks, or activates the audio file to play the music, this SLI is immediately available since it is included with or is part of the audio file. The software application executing the audio file (e.g., playing the music to the listener) is not required to execute processing steps to determine the location of or assemble the user specific data (e.g., HRTFs). It is also not required to execute processing to determine sound specific and/or localization specific (e.g., HRTF pairs, coordinates, SLPs, zones) data in order to convolve or process the sound so it externally localizes to the listener. Instead, this information is included with, embedded with, packaged with, or is part of the audio file or the information in its transmission.

As yet another example, SLI, SLPs, zones, and/or coordinate information is stored in a lookup table. When a user or software application requests to externally localize sound, the information necessary for determining the sound location or executing the convolution or localization is retrieved from the lookup table. A lookup table is an array that replaces runtime computation with an array indexing operation in order to expedite processing time. For example, the lookup table stores the HRTFs, ILD, ITD, and/or coordinates of the SLP and thus saves execution of a computation or input/output (I/O) operation.

For example, the lookup table is stored as a file or component of a file or data stream. Alternatively, the file also includes the sound, such as the sound data and/or a pointer to a location of the sound or sound data and/or other sounds. For example, the file includes the sound data and also includes a URL to the sound data stored in a separate location. As another example, the lookup table included in the data or sound stream includes a pointer to or identification of the sound (e.g. a filename such as a local filename). In this example, an application or a process executing the sound localization operating on the computer system or electronic device receives the lookup table with the SLI at the start of the transmission of the stream. In the event of network congestion or fault, the

application refers to the pointer in order to find an alternate source of the sound or sound data. The application continues to localize the sound retrieved from the alternate source without relying on the timely delivery of the sound from the stream. In addition, the application fetches the sound data from the alternate

5 source in advance of the playing of the sound in order to pre-convolve the sound and/or analyze the sound to improve the performance of the delivery of localized sound to the user. This prefetched data can also be cached, such as caching in L1 or L2 memory.

10 As yet another example, a 3D area away from a user includes tens, hundreds, or thousands of SLPs. Retrieving and processing such a large number of SLPs and associated sound localization information are process intensive, are process expensive, and consume local memory space. SLPs and sound localization information in a restricted zone or area are ignored in order to significantly

15 reduce process execution steps and time. For instance, SLPs in and/or sound localization information for an active or predicted zone for an executing software application (or software application about to execute) are prefetched and/or preprocessed. SLPs and/or sound localization information are not prefetched when a determination is made that they exist in an inactive zone, a restricted

20 zone, or a zone to which the software application is not localizing sound, is not predicted or permitted to localize sound, or will not localize sound.

Consider an example in which a user previously provided instructions or commands to externally localize a voice in a telephone call or VR software game

25 to SLP 1 and SLP 7. When the user executes the telephone application or VR software game, the application prefetches SLI for SLP 1 and SLP 7 before the user makes a command or a request that requires this information. If the user thereafter instructs or commands to externally localize the voice to SLP 1 or SLP 7, then this information is already retrieved and preprocessed to expedite

30 convolution of the voice. For example, the SLP selector queries a localization log to find prior localization instances of localization to SLP 1 and SLP 7, and

retrieves the SLI associated with those instances such as the HRTFs or HRTF pairs and/or the sound or resource reference or link to the sound. The SLP selector retrieves the sound for preprocessing. The SLP selector also retrieves the HRTFs, parses the HRTFs for the HRTF pairs that were used in the instance,
5 and processes the HRTF pairs in the preprocessing.

Figure 9 is a method to increase or improve performance of a computer by expediting convolving and/or processing of sound to localize at a SLP in accordance with an example embodiment.

10

Block 900 states determine a software application that an electronic device of a user is executing or will execute and/or determine a type of binaural sound that the user will hear from the software application.

15 By way of example, this determination includes, but is not limited to, one or more of the following: what software application is currently executing on the electronic device (e.g., a user opens, in a smartphone, a messaging application that provides binaural sound to the user), what type of binaural sound the user is currently hearing with the software application (e.g., voice, music, voice and
20 music, segmented audio or diarized audio, recorded binaural sound, streaming binaural sound, convolved binaural sound, un-convolved binaural sound that requires convolution, mono sound convolved to binaural sound, stereo sound convolved to binaural sound, etc.), what type of binaural sound the user previously or historically heard with the software application, what type of
25 binaural sound other users heard with the software application, what type of binaural sound the software application can execute and/or provide to the user, what software application is stored on the electronic device (e.g., what software applications that externally localize binaural sound to the user), what window is open or active or has focus on the electronic device (e.g., a user moves a
30 window from a background to a foreground on a display for a HMD or HPED), what software application is making a request to the electronic device (e.g., the

user receives a phone call on a VoIP software application that externally localizes voices in binaural sound), what information or data is being transmitted to or transmitted from the electronic device (e.g., a WED of the user downloads a file that includes binaural sound), a time of day or date (e.g., binaural sound is
5 scheduled to externally localize to the user at a known time in the future), a geographical location (e.g., the user is walking toward a store location that provides advertisements in binaural sound to users passing-by), a command or request to another electronic device or another software application (e.g., a user makes a verbal command to an IPA executing on a smart speaker and the smart
10 speaker will provide a response in binaural sound to earphones of the user), and other examples discussed herein.

Block 910 states determine SLPs, zones, and/or SLI that the software application will execute to externally localize the binaural sound to the user.

15 An example embodiment assigns or designates one or more SLPs, zones, and/or other SLI to software applications. These assignments or designations and accompanying information are retrieved from memory or otherwise obtained (e.g., received over a wired or wireless transmission, received from a file, received
20 from a software application, etc.).

Block 920 states prefetch, based on the determination of the software application and/or the type of sound, SLPs, zones, and/or SLI to convolve and/or process sound so the sound externally localizes as the binaural sound at a SLP and/or a
25 zone to the user.

By way of example, the SLPs, zones, and/or SLI include, but are not limited to, one or more of HRTFs, HRIRs, RIRs, SLPs, BRIRs, user preferences for SLPs, coordinate locations of the SLP and/or zone, user preferences of SLPs and/or
30 zones, and other information (such as information discussed in connection with information about sound and sound localization information).

Block 930 states preprocess and/or store the SLPs, zones, and/or SLI to expedite convolving and/or processing of the sound to localize as the binaural sound at the SLP and/or the zone to the user.

5

In an example embodiment, a processor or preprocessor executes or processes the data relating to sound localization of binaural sound (e.g., SLPs, zones, and/or SLI).

- 10 A preprocessor is a program that processes the retrieved data to produce output that is used as input to another program. This output can be generated in anticipation of the use of the output data. For example, an example embodiment predicts a likelihood of requiring the output data for binaural sound localization and preprocesses the data in anticipation of a request for the data. For instance,
- 15 the program retrieves one or more files including HRTF pairs and extracts data from the files that will be used to convolve the sound to localize as binaural sound at a location specified with the HRTF pair data. This extracted or preprocessed data is quickly or more efficiently provided to a DSP in the event the sound is convolved with the HRTF pair.

20

This preprocessing also includes multiple different SLPs that are anticipated or predicted to be used by a software application. For example, a user dons a HMD and activates a conference calling VR program that enables the user to execute telephone calls in a VR environment. An example embodiment reviews SLPs that

25 were previously used by the VR program and retrieves SLI so sound can be convolved and localized to these SLPs. The retrieval of this binaural sound information occurs before a request is made for binaural sound to localize to a SLP.

- 30 As another example, the processor requests a data block (or an instruction block) from main memory before the data block is actually needed. The data block is

placed or stored in cache memory or local memory so the data is quickly accessed and processed to externally localize binaural sound to the user. Prefetching of this data reduces latency associated with memory access. This data block includes SLPs, zones, and/or SLI. For example, the data block includes coordinate locations of one or more SLPs and HRTFs, ITDs, and/or ILDs for the SLPs at these coordinate locations and coordinates that define zones.

Consider an example in which the location of the user with respect to an object is used to prefetch data. For example, a user is 1.5 meters away from an object or other external localization point that might serve as a SLP for a telephone call, game, voice of an IPA. The object is at a same elevation as a head of the user. This distance of 1.5 meters remains relatively fixed, though the head orientation of the user changes or moves. In response to this information, the system prefetches SLPs and corresponding HRTF pairs that have a distance of 1.5 meters with an elevation of zero degrees. For example, the system prefetches SLPs and/or HRTFs corresponding to (1.5m, X° , 0°), where X is an integer. Here, the X represents different azimuth angles to which the user might move his or her head when sound convolving commences. For instance, the system retrieves HRTF data corresponding to (1.5m, 0° , 0°), (1.5m, 5° , 0°), (1.5m, 10° , 0°), (1.5m, 15° , 0°), ... (1.5m, 355° , 0°). Alternatively, the system retrieves other azimuth intervals, such as retrieving HRTF data for every 3° , 6° , 10° , 15° , 20° , or 25° . When convolution commences, the data for the particular azimuth angle has already been retrieved and is available in cache or local memory for the processor to quickly expedite convolution of the sound.

Consider an example in which a user has a smart speaker that includes a VPA or an intelligent personal assistant (named Hal) that answers questions and performs other tasks via a natural language user interface and speaker located inside the smart speaker. When the user is proximate to the smart speaker, the user can ask Hal questions (e.g., What time is it?) or ask Hal to play music (e.g.,

Play Beethoven). Sound emanates from one or more speakers in the smart speaker so the user can hear the answer, listen to music, etc. When the user wears wireless earphones, however, the sound does not emanate from speakers located inside the smart speaker. Instead, the sound is provided to the user
5 through the earphones, and the sound convolves such that it externally localizes at the location of the smart speaker. In this instance, speakers in the smart speaker actually do not play any sound. Instead, the sound is convolved to a SLP located at the physical object, which is the smart speaker itself. The sound is also convolved to externally localize at other SLPs, such as SLPs in 3D space around
10 the user or other SLPs or zones discussed herein.

Consider further this example of the smart speaker with an IPA named Hal. When the user wears wireless earphones and walks into the room near the smart speaker, the computer system recognizes that sound will be provided through the
15 earphones and not through the speaker of the smart speaker. Even though the user has not yet made a verbal request or command to Hal, the computer system (or an electronic device on the user, such as smartphone) tracks a location of the user with respect to the smart speaker and retrieves sound data based on this location information. For example, this sound data includes a volume of sound to
20 provide to the user based on the distance, an azimuth and/or elevation angle of the user with respect to the fixed location of the smart speaker, HRTF pairs that are specific to or individualized to the user, and/or information about coordinates, SLPs, and/or zones where sound from the IPA such as the voice of Hal can or might localize to the user. This information is stored in a cache with or near the
25 DSP. If the user makes a verbal request to Hal (e.g., What time is it?), the distance/SLP and HRTF data are already retrieved and cached. In this instance, a cache hit occurs since the requested data to convolve the sound has already been retrieved. The DSP quickly convolves the data based on the location of the user with respect to the smart speaker so the voice of Hal localizes to the
30 physical speaker of the smart speaker. By way of example, the DSP includes a

Harvard architecture or modified Harvard architecture with shared L2, split L1 I-cache and/or D-cache to store the cached data.

5 Consider further this example of the smart speaker with an IPA, Hal. As the user walks around a room where the smart speaker is located, a head orientation of the user is continually or continuously tracked with respect to the physical location of the smart speaker. This head orientation includes an azimuth angle to the smart speaker, an elevation angle to the smart speaker, and a distance from the head of the user to the smart speaker. Sound localization information (e.g.,
10 including a HRTF pair) is continuously or continually retrieved for each new head orientation. For instance, the coordinates of the HRTF pair match or correspond to the azimuth angle, elevation angle, and distance of the smart speaker with respect to the head orientation of the user. If the user asks Hal a question at any moment in time, the corresponding SLI is already retrieved so that the voice of
15 Hal can be convolved according to the current head orientation of the listener. For instance, electronic earphones on the user provide the voice of Hal such that the voice originates from the location of the smart speaker even though the speakers inside the smart speaker are not providing the voice response. Instead, the earphones provide the voice response to the user who hears the voice of Hal
20 as originating from the location of the smart speaker.

Figure 10 is a method to process and/or convolve sound so the sound externally localizes as binaural sound to a user in accordance with an example embodiment.

25 Block 1000 states determine a location from where sound will externally localize to a user.

Binaural sound localizes to a location in 3D space to a user. This location is external to and away from the body of the user.

30

An electronic device, software application, and/or a user determines the location for a user who will hear the sound produced in his physical environment or in an augmented reality (AR) environment or a virtual reality (VR) environment. The location can be expressed in a frame of reference of the user (e.g., the head,
5 torso, or waist), the physical or virtual environment of the user, or other reference frames. Further, this location can be stored or designated in memory or a file, transmitted over one or more networks, determined during and/or from an executing software application, or determined in accordance with other examples discussed herein. For example, the location is not previously known or stored but
10 is calculated or determined in real-time. As another example, the location of the sound is determined at a point in time when a software application makes a request to externally localize the sound to the user or executes instructions to externally localize the sound to the user. Further, the location can be in empty or unoccupied 3D space or in 3D space occupied with a physical object or a virtual
15 object.

The location where to localize the sound can also be stored at and/or originate from a physical object or electronic device that is separate from the electronic device providing the binaural sound to the user (e.g., separate from the electronic
20 earphones, HMD, WED, smartphone, or other PED with or on the user). For instance, the physical object is an electronic device that wirelessly transmits its location or the location where to localize sound to the electronic device processing and/or providing the binaural sound to the user. Alternatively, the physical object can be a non-electronic device (e.g., a teddy bear, a chair, a table,
25 a person, a picture in a picture frame, etc.).

Consider an example in which the location is at a physical object (as opposed to the location being in empty space). In order to determine a location of the physical object and hence the location where to localize the sound, the electronic
30 system executes or uses one or more of object recognition (such as software or human visual recognition), an electronic tag located at the physical object (e.g.,

RFID tag), global positioning satellite (GPS), indoor positioning system (IPS), Internet of things (IoT), sensors, network connectivity and/or network communication, or other software and/or hardware that recognize or locate a physical object.

5

Zones can be defined in terms of one or more of the locations of the objects, such as a zone defined by points within a certain distance from the object or objects, a linear zone defined by the points between two objects, a surface or 2D zone defined by points within a perimeter having vertices at three or more objects, a 3D zone defined by points within a volume having vertices at four or more objects, etc. Some of the discussed methods and other methods for determining the location of objects determine a location of objects as well as locations near the object location to varying distances. The data that describes the nearby locations can be used to define a zone. For example, a sensor measures the strength of radio signals in an area. A software application analyzes the sensor data and determines two maximum measured strengths at (0, 0, 0), and (0, 1, 0) that correspond to the locations of two signal emitters. The software application reports the two coordinates to the SLP selector, and the SLP selector designates the two coordinates as two SLPs. The SLP selector requests a zone instead of SLP coordinates. In response to the request, the software application analyzes the sensor data and returns the coordinates corresponding to signal strengths of 85% of the maximum strength. The coordinates form a shape of two intersecting spheres, and this shape, the volume enclosed by the two spheres, defines the zone.

25

Additionally, the location may be in empty space but based on a location of a physical object. For example, the location in empty space is next to or near a physical object (e.g., within an inch, a few inches, a foot, a few feet, a meter, a few meters, etc. of the physical object). The physical object can thus provide a relative location or known location for the location in empty space since the

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location in empty space is based on a relative position with respect to the physical object.

Consider an example in which the physical object transmits a GPS location to a smartphone or WED of a user. The smartphone or WED includes hardware and/or software to determine its own GPS location and a point of direction or orientation of the user (e.g., a compass direction where the smartphone or WED is pointed or where the user is looking or directed, such as including head tracking). Based on this GPS and directional information, the smartphone or WED calculates a location proximate to the physical object (e.g., away from but within one meter of the physical object). This location becomes the SLP. The smartphone or WED retrieves SLI corresponding to, matching or approximating this SLP, convolves the sound with this SLI, and provides the convolved sound as binaural sound to the user so the binaural sound localizes to the SLP that is proximate to the physical object.

Location can include a general direction, such as to the right of the listener, to the left of the listener, above the listener, behind the listener, in front of the listener, etc. Location can be more specific, such as including a compass direction, an azimuth angle, an elevation angle, a coordinate location (e.g., an X-Y-Z coordinate), or an orientation. Location can also include distance information that is specific or general. For example, specific distance information would be a number, such as 1.0 meters, 1.1 meters, 1.2 meters, etc. General distance information would be less specific or include a range, such as the distance being near-field, the distance being far-field, the distance being greater than one meter, the distance being less than one meter, the distance being between one to two meters, etc.

As one example, a PED (such as a HPED, or a WED) communicates with the physical object using radio frequency identification (RFID) or near-field communication (NFC). For instance, the PED includes a RFID reader or NFC

reader, and the physical object includes a passive or active RFID tag or a NFC tag. Based on this communication, the PED determines a location and other information of the physical object with respect to the PED.

- 5 As another example, a PED reads or communicates with an optical tag or quick response (QR) code that is located on or near the physical object. For example, the physical object includes a matrix barcode or two-dimensional bar code, and the PED includes a QR code scanner or other hardware and/or software that enables the PED to read the barcode or other type of code.

10

As another example, the PED includes Bluetooth low energy (BLE) hardware or other hardware to make the PED a Bluetooth enabled or Bluetooth Smart device. The physical object includes a Bluetooth device and a battery (such as a button cell) so that the two enabled Bluetooth devices (e.g., the PED and the physical
15 object) wirelessly communicate with each other and exchange information.

As another example, the physical object includes an integrated circuit (IC) or system on chip (SoC) that stores information and wirelessly exchanges this information with the PED (e.g., information pertaining to its location, identity,
20 angles and/or distance to a known location, etc.).

As another example, the physical object includes a low energy transmitter, such as an iBeacon transmitter. The transmitter transmits information to nearby PEDs, such as smartphones, tablets, WEDs, and other electronic devices that are within
25 a proximity of the transmitter. Upon receiving the transmission, the PED determines its relative location to the transmitter and determines other information as well.

As yet another example, an indoor positioning system (IPS) locates objects,
30 people, or animals inside a building or structure using one or more of radio waves, magnetic fields, acoustic signals, or other transmission or sensory

information that a PED receives or collects. In addition to or besides radio technologies, non-radio technologies can be used in an IPS to determine position information with a wireless infrastructure. Examples of such non-radio technology include, but are not limited to, magnetic positioning, inertial measurements, and
5 others. Further, wireless technologies can generate an indoor position and be based on, for example, a Wi-Fi positioning system (WPS), Bluetooth, RFID systems, identity tags, angle of arrival (AoA, e.g., measuring different arrival times of a signal between multiple antennas in a sensor array to determine a signal origination location), time of arrival (ToA, e.g., receiving multiple signals
10 and executing trilateration and/or multi-lateration to determine a location of the signal), received signal strength indication (RSSI, e.g., measuring a power level received by one or more sensors and determining a distance to a transmission source based on a difference between transmitted and received signal strengths), and ultra-wideband (UWB) transmitters and receivers. Object detection and
15 location can also be achieved with radar-based technology (e.g., an object-detection system that transmits radio waves to determine one or more of an angle, distance, velocity, and identification of a physical object).

One or more electronic devices in the IPS, network, or electronic system collect
20 and analyze wireless data to determine a location of the physical object using one or more mathematical or statistical algorithms. Examples of such algorithms include an empirical method (e.g., k-nearest neighbor technique) or a mathematical modeling technique that determines or approximates signal propagation, finds angles and/or distance to the source of signal origination, and
25 determines location with inverse trigonometry (e.g., trilateration to determine distances to objects, triangulation to determine angles to objects, Bayesian statistical analysis, and other techniques).

The PED determines information from the information exchange or
30 communication exchange with the physical object. By way of example, the PED determines information about the physical object, such as a location and/or

orientation of the physical object (e.g., a GPS coordinate, an azimuth angle, an elevation angle, a relative position with respect to the PED, etc.), a distance from the PED to the physical object, object tracking (e.g., continuous, continual, or periodic tracking of movements or motions of the PED and/or the physical object with respect to each other), object identification (e.g., a specific or unique identification number or identifying feature of the physical object), time tracking (e.g., a duration of communication, a start time of the communication, a stop time of the communication, a date of the communication, etc.), and other information.

10 As yet another example, the PED captures an image of the physical object and includes or communicates with object recognition software that determines an identity and location of the object. Object recognition finds and identifies objects in an image or video sequence using one or more of a variety of approaches, such as edge detection or other CAD object model approach, a method based on appearance (e.g., edge matching), a method based on features (e.g., matching object features with image features), and other algorithms.

In an example embodiment, the location or presence of the physical object is determined by an electronic device (such as a HPED, or PED) communicating with or retrieving information from the physical object or an electronic device (e.g., a tag) attached to or near the physical object.

In another example embodiment, the electronic device does not communicate with or retrieve information from the physical object or an electronic device attached to or near the physical object (e.g., retrieving data stored in memory). Instead, the electronic device gathers location information without communicating with the physical object or without retrieving data stored in memory at the physical object.

30 As one example, the electronic device captures a picture or image of the physical object, and the location of the object is determined from the picture or image. For

instance, when a size of a physical object is known, distance to the object can be determined by comparing a relative size of the object in the image with the known actual size.

- 5 As another example, a light source in the electronic device bounces light off the object and back to a sensor to determine the location of the object.

As yet another example, the location of the physical object is not determined by communicating with the physical object. Instead, the electronic device or a user
10 of the electronic device selects a direction and/or distance, and the physical object at the selected direction and/or distance becomes the selected physical object. For example, a user holds a smartphone and points it at a compass heading of 270° (East). An empty chair is located along this compass heading and becomes the designated physical object since it is positioned along the
15 selected compass heading.

Consider another example in which the physical object is not determined by communicating with the physical object. An electronic device (such as a smartphone) includes one or more inertial sensors (e.g., an accelerometer,
20 gyroscope, and magnetometer) and a compass. These devices enable the smartphone to track a position and/or orientation of the smartphone. A user or the smartphone designates and stores a certain orientation as being the location where sound will localize. Thereafter, when the orientation and/or position changes, the smartphone tracks a difference between the stored designated
25 location and the changed position (e.g., its current position).

Consider another example in which an electronic device captures video with a camera and displays this video in real time on the display of the electronic device. The user taps or otherwise selects a physical object shown on the display, and
30 this physical object becomes the designated object. The electronic device records a picture of the selected object and orientation information of the

electronic device when the object is selected (e.g., records an X-Y-Z position, and a pitch, yaw and roll of the electronic device).

As another example, a three-dimensional (3D) scanner captures images of a physical object or a location (such as one or more rooms), and three-dimensional models are built from these images. The 3D scanner creates point clouds of various samples on the surfaces of the object or location, and a shape is extrapolated from the points through reconstruction. A point cloud can define the zone. The extrapolated 3D shape can define a zone. The 3D generated shape or image includes distances between points and enables extrapolation of 3D positional information for each object or zone. Examples of non-contact 3D scanners include, but are not limited to, time-of-flight 3D scanners, triangulation 3D scanners, and others.

Block 1010 states process and/or convolve the sound with SLI that corresponds to the location such that the sound processed and/or convolved with the SLI will externally localize to the user at the location.

By way of example, the sound localization information (SLI) are retrieved, obtained, or received from memory, a database, a file, an electronic device (such as a server, cloud-based storage, or another electronic device in the computer system or in communication with a PED providing the sound to the user through one or more networks), etc. For instance, this information includes one or more of HRTFs, ILDs, ITDs, and/or other information discussed herein. As noted, this information can also be calculated in real-time.

An example embodiment processes and/or convolves sound with the SLI so the sound localizes to a particular area or point with respect to a user. The SLI required to process and/or convolve the sound is retrieved or determined based on a location of the SLP. For example, if the SLP is located one meter in front of a face of the listener and slightly off to a right side of the listener, then an

example embodiment retrieves the corresponding HRTFs, ITDs, and ILDs and convolves the sound to this location. The location can be more specific, such as a precise spherical coordinate location of (1.2 m, 25°, 15°), and the HRTFs, ITDs, and ILDs are retrieved that correspond to this location. For instance, the retrieved
5 HRTFs have a coordinate location that matches or approximates the coordinate location of the location where sound is desired to originate to the user. Alternatively, the location is not provided but the SLI is provided (e.g., a software application provides the DSP with the HRTFs and other information to convolve the sound).

10

A central processing unit (CPU), processor (such as a digital signal processor or DSP), or microprocessor processes and/or convolves the sound with the SLI, such as a pair of head related transfer functions (HRTFs), ITDs, and/or ILDs so the sound localizes to a zone or SLP. For example, the sound localizes to a
15 specific point (e.g., localizing to point (R, θ , ϕ)) or a general location or area (e.g., localizing to far-field location (θ , ϕ) or near-field location (θ , ϕ)). As an example, a lookup table that stores a HRTF includes a field/column for HRTF pairs and includes a column that specifies the coordinates associated with each pair, and the coordinates indicate the location for the origination of the sound. These
20 coordinates can include a distance (R) or near-field or far-field designation, an azimuth angle (θ), and/or an elevation angle (ϕ).

The complex and unique shape of the human pinnae transforms sound waves through spectral modifications as the sound waves enter the ear. These spectral
25 modifications are a function of the position of the source of sound with respect to the ears along with the physical shape of the pinnae that together cause a unique set of modifications to the sound called head related transfer functions or HRTFs. A unique pair of HRTFs (one for the left ear and one for the right ear) can be modeled or measured for each position of the source of sound with respect to a
30 listener.

A HRTF is a function of frequency (f) and three spatial variables, by way of example (r, θ, ϕ) in a spherical coordinate system. Here, r is the radial distance from a recording point where the sound is recorded or a distance from a listening point where the sound is heard to an origination or generation point of the sound;

5 θ (theta) is the azimuth angle between a forward-facing user at the recording or listening point and the direction of the origination or generation point of the sound relative to the user; and ϕ (phi) is the polar angle, elevation, or elevation angle between a forward-facing user at the recording or listening point and the direction of the origination or generation point of the sound relative to the user. By way of

10 example, the value of (r) can be a distance (such as a numeric value) from an origin of sound to a recording point (e.g., when the sound is recorded with microphones) or a distance from a SLP to a head of a listener (e.g., when the sound is generated with a computer program or otherwise provided to a listener).

15 When the distance (r) is greater than or equal to about one meter (1 m) as measured from the capture point (e.g., the head of the person) to the sound source, the sound attenuates inversely with the distance. One meter or thereabout defines a practical boundary between near field and far field distances and corresponding HRTFs. A “near field” distance is one measured at

20 about one meter or less; whereas a “far field” distance is one measured at about one meter or more. Example embodiments can be implemented with near field and far field distances.

The coordinates for external sound localization can be calculated or estimated

25 from an interaural time difference (ITD) of the sound between two ears. ITD is related to the azimuth angle according to, for example, the Woodworth model that provides a frequency independent ray tracing methodology. The model assumes a rigid, spherical head and a sound source at an azimuth angle. The time delay varies according to the azimuth angle since sound takes longer to

30 travel to the far ear. The ITD for a sound source located on a right side of a head of a person is given according to two formulas:

ITD = $(a/c)[\theta + \sin(\theta)]$ for situations in which $0 \leq \theta \leq \pi/2$; and

ITD = $(a/c)[\pi - \theta + \sin(\theta)]$ for situations in which $\pi/2 \leq \theta \leq \pi$,

5

where θ is the azimuth in radians ($0 \leq \theta \leq \pi$), a is the radius of the head, and c is the speed of sound. The first formula provides the approximation when the origin of the sound is in front of the head, and the second formula provides the approximation when the origin of the sound is in the back of the head (i.e., the azimuth angle measured in degrees is greater than $\pm 90^\circ$).

10

By way of example, the coordinates (r, θ, ϕ) for external sound localization can also be calculated from a measurement of an orientation of and a distance to the face of the person when the HRIRs are captured.

15

The coordinates can also be calculated or extracted from one or more HRTF data files, for example by parsing known HRTF file formats, and/or HRTF file information. For example, HRTF data is stored as a set of angles that are provided in a file or header of a file (or in another predetermined or known location of a file or computer readable medium). This data can include one or more of time domain impulse responses (FIR filter coefficients), filter feedback coefficients, and an ITD value. This information can also be referred to as “a” and “b” coefficients. By way of example, these coefficients can be stored or ordered according to lowest azimuth to highest azimuth for different elevation angles. The HRTF file can also include other information, such as the sampling rate, the number of elevation angles, the number of HRTFs stored, ITDs, a list of the elevation and azimuth angles, a unique identification for the HRTF pair, and other information. This data can be arranged according to one or more standard or proprietary file formats, such as AES69 or a panorama file format, and extracted

20

25

from the file.

The coordinates and other HRTF information are calculated or extracted from the HRTF data files. A unique set of HRTF information (including r , θ , ϕ) is
5 determined for each unique HRTF.

The coordinates and other HRTF information are also stored in and retrieved from memory, such as storing the information in a look-up table. This information is quickly retrieved to enable real-time processing and convolving of sound using
10 HRTFs and hence improves computer performance of execution of binaural sound.

The SLP represents a location where a person will perceive an origin of the sound. For an external localization, the SLP is away from the person (e.g., the
15 SLP is away from but proximate to the person or away from but not proximate to the person). The SLP can also be located inside the head of the person.

A location of the SLP corresponds to the coordinates of one or more pairs of HRTFs. For example, the coordinates of or within a SLP or a zone match or
20 approximate the coordinates of a HRTF. Consider an example in which the coordinates for a pair of HRTFs are (r, θ, ϕ) and are provided as (1.2 meters, 35° , 10°). A corresponding SLP or zone for a person thus includes (r, θ, ϕ) , provided as (1.2 meters, 35° , 10°). In other words, the person will localize the sound as occurring 1.2 meters from his or her face at an azimuth angle of 35° and at an
25 elevation angle of 10° taken with respect to a forward looking direction of the person. In this example, the coordinates of the SLP and HRTF correspond or match.

The coordinates for a SLP can also be approximated or interpolated based on
30 known data or known coordinate locations. For example, a SLP is desired for coordinate location (2.0 m, 0° , 40°), but HRTFs for this location are not known.

HRTFs are known for two neighboring locations, such as known for (2.0 m, 0°, 35°) and (2.0 m, 0°, 45°), and the HRTFs for the desired location of (2.0 m, 0°, 40°) are approximated from the two known locations. These approximated HRTFs are provided as the SLP desired for the coordinate location (2.0 m, 0°, 40°).

The SLP represents a location where the person will perceive an origin of the sound. Example embodiments designate or include an object at this SLP. For an external localization, the SLP is away from the person (e.g., the SLP is away from but proximate to the person or away from but not proximate to the person). The SLP can also be located inside the head of the person (e.g., when sound is provided to the listener in stereo or mono sound).

Listeners may not localize sound to an exact or precise location or a location that corresponds with an intended location. In some instances, the location where the computer system or electronic device convolves the sound may not align with or coincide with the location where the listener perceives the source of the sound. For example, the computer-generated SLP may not align with the SLP where the listener localizes the origin of the sound. For example, a listener commands a software application or a process to localize a sound to a SLP having coordinates (2 m, 45°, 0°), but the listener perceives the sound farther to his right at 55° azimuth. This difference in location or error may be slight (e.g., one or two degrees in azimuth and/or elevation) or may be greater.

Consider an example in which the relative coordinates between the physical object and a head orientation of the listener are as follows: the distance from the listener to the physical object is two meters ($R = 2.0$ m); the azimuth angle between the head orientation of the listener and the physical object is twenty-five degrees ($\theta = 25^\circ$); and the elevation angle between the head orientation of the listener and the physical object is zero degrees ($\varphi = 0^\circ$). The computer system or an electronic device in the computer system retrieves or receives a HRTF pair

that has an associated sound localization point or SLP of $(R, \theta, \phi) = (2.0 \text{ m}, 25^\circ, 0^\circ)$. When sound is convolved with this HRTF pair, the sound will localize to the listener to the SLP at $(2.0 \text{ m}, 25^\circ, 0^\circ)$.

- 5 Block 1020 states provide the processed and/or convolved sound to the user as binaural sound that externally localizes to the user at the location.

Binaural sound can be provided to the listener through bone conduction headphones, speakers of a wearable electronic device (e.g., headphones,
10 earphones, electronic glasses, head mounted display, smartphone, etc.), or the binaural sound can be processed for crosstalk cancellation and provided through other types of speakers (e.g., dipole stereo speakers).

From the point-of-view of the listener, the sound originates or emanates from the
15 object, point, area, or location that corresponds with the SLP. For example, an example embodiment selects a SLP location at, on, or near a physical object, a VR object, or an AR object. When the sound is convolved with the HRTFs corresponding with the SLP, then the sound appears to originate to the listener at the object.

20

When binaural sound is provided to the listener, the listener will hear the sound as if it originates from the object (assuming an object is selected for the SLP). The sound, however, does not actually originate from the object since the object may be an inanimate object with no electronics or an animate object with no
25 electronics. Alternatively, the object could have electronics but not have the capability to generate sound (e.g., the object has no speakers or sound system). As yet another example, the object could have speakers and the ability to provide sound but is not actually providing sound to the listener. In each of these examples, the listener perceives the sound to originate from the object, but the
30 object does not produce the sound. Instead, the sound is altered or convolved and provided to the listener so the sound appears to originate from the object.

Other technical problems exist with binaural sound, such as how to divide or partition 2D and/or 3D space around a user. How many zones should this space or area include? What sizes should these zones have? What shapes should these zones have? What should be the origin of these zones? What types of sound or software applications should be assigned or designated to the space or area?

Another problem is that listeners may not like or can confuse different sounds if SLPs of these different sounds are too close together. Further, a listener can fail to localize multiple sounds or sounds with differing characteristics when localized to a matching or near matching location. This situation can occur when the relative azimuth and/or elevation distance between two SLPs is too small.

Example embodiments provide solutions to these problems and many others. These example embodiments not only solve these problems but also improve execution and/or convolution of binaural sound to externally localize to one or more SLPs that are in 3D space around a listener.

Figures 11 – 13 show examples of different SLPs and/or zones that include one or more SLPs. For illustration, a head of a user is positioned at an origin of the coordinate system or location, but example embodiments are not limited to positioning the head of the user at this location. Figures 11 and 12 show SLPs and/or zones in a polar coordinate system, but other coordinates systems can be used as well (such as spherical coordinate system, Cartesian coordinate system, etc.). Further, for illustration, some drawings illustrate a clockwise rotation with zero degrees (0°) representing a line-of-sight or direction that a user is facing. Further, when specific values for (r, θ, ϕ) are provided, example embodiments also include values for about (r, θ, ϕ) .

30

Figure 11A shows a coordinate system 1100A with a plurality of zones having different azimuth coordinates in accordance with an example embodiment. By way of example, three zones with different coordinates are shown. These zones include the following:

- 5 Zone 1: $\theta = 0^\circ$ to 90° or $0^\circ \leq \theta \leq 90^\circ$;
 Zone 2: $\theta = 270^\circ$ to 360° or $270^\circ \leq \theta \leq 360^\circ$; and
 Zone 3: $\theta = 90^\circ$ to 270° or $90^\circ \leq \theta \leq 270^\circ$.

10 Figure 11B shows a coordinate system 1100B with a plurality of zones having different azimuth coordinates in accordance with an example embodiment. By way of example, six zones with different coordinates are shown. These zones include the following:

- Zone 1: $\theta = 345^\circ$ to 15° or $345^\circ \leq \theta \leq 15^\circ$;
 Zone 2: $\theta = 15^\circ$ to 45° or $15^\circ \leq \theta \leq 45^\circ$;
15 Zone 3: $\theta = 315^\circ$ to 345° or $315^\circ \leq \theta \leq 345^\circ$;
 Zone 4: $\theta = 45^\circ$ to 90° or $45^\circ \leq \theta \leq 90^\circ$;
 Zone 5: $\theta = 270^\circ$ to 315° or $270^\circ \leq \theta \leq 315^\circ$; and
 Zone 6: $\theta = 135^\circ$ to 225° or $135^\circ \leq \theta \leq 225^\circ$.

20 Figure 11C shows a coordinate system 1100C with a plurality of zones having different azimuth coordinates in accordance with an example embodiment. By way of example, four zones with different coordinates are shown. These zones include the following:

- Zone 1: $\theta = 330^\circ$ to 30° or $330^\circ \leq \theta \leq 30^\circ$;
25 Zone 2: $\theta = 30^\circ$ to 60° or $30^\circ \leq \theta \leq 60^\circ$;
 Zone 3: $\theta = 300^\circ$ to 330° or $300^\circ \leq \theta \leq 330^\circ$; and
 Zone 4: $\theta = 60^\circ$ to 300° or $60^\circ \leq \theta \leq 300^\circ$.

30 Figure 11D shows a coordinate system 1100D with a plurality of zones having different azimuth coordinates in accordance with an example embodiment. By

way of example, six zones with different coordinates are shown. These zones include the following:

- 5
- Zone 1: $\theta = 335^\circ$ to 25° or $335^\circ \leq \theta \leq 25^\circ$;
 - Zone 2: $\theta = 25^\circ$ to 50° or $25^\circ \leq \theta \leq 50^\circ$;
 - Zone 3: $\theta = 310^\circ$ to 335° or $310^\circ \leq \theta \leq 335^\circ$;
 - Zone 4: $\theta = 50^\circ$ to 155° or $50^\circ \leq \theta \leq 155^\circ$;
 - Zone 5: $\theta = 205^\circ$ to 310° or $205^\circ \leq \theta \leq 310^\circ$; and
 - Zone 6: $\theta = 155^\circ$ to 205° or $155^\circ \leq \theta \leq 205^\circ$.

- 10 Figure 11E shows a coordinate system 1100E with a plurality of zones having different azimuth coordinates in accordance with an example embodiment. By way of example, five zones with different coordinates are shown. These zones include the following:

- 15
- Zone 1: $\theta = 298^\circ$ to 0° or $298^\circ \leq \theta \leq 0^\circ$;
 - Zone 2: $\theta = 0^\circ$ to 62° or $0^\circ \leq \theta \leq 62^\circ$;
 - Zone 3: $\theta = 62^\circ$ to 104° or $62^\circ \leq \theta \leq 104^\circ$;
 - Zone 4: $\theta = 256^\circ$ to 298° or $256^\circ \leq \theta \leq 298^\circ$; and
 - Zone 5: $\theta = 325^\circ$ to 35° or $325^\circ \leq \theta \leq 35^\circ$.

- 20 Figure 12A shows a coordinate system 1200A with a plurality of zones having different elevation coordinates in accordance with an example embodiment. By way of example, four zones with different coordinates are shown. These zones include the following:

- 25
- Zone 1: $\varphi = 0^\circ$ to 30° or $0^\circ \leq \varphi \leq 30^\circ$;
 - Zone 2: $\varphi = 30^\circ$ to 150° or $30^\circ \leq \varphi \leq 150^\circ$;
 - Zone 3: $\varphi = 150^\circ$ to 180° or $150^\circ \leq \varphi \leq 180^\circ$; and
 - Zone 4: $\varphi = 180^\circ$ to 360° or $180^\circ \leq \varphi \leq 360^\circ$.

- 30 Figure 12B shows a coordinate system 1200B with a plurality of zones having different elevation coordinates in accordance with an example embodiment. By

way of example, four zones with different coordinates are shown. These zones include the following:

- 5 Zone 1: $\varphi = 340^\circ$ to 45° or $340^\circ \leq \varphi \leq 45^\circ$;
 Zone 2: $\varphi = 45^\circ$ to 135° or $45^\circ \leq \varphi \leq 135^\circ$;
 Zone 3: $\varphi = 135^\circ$ to 200° or $135^\circ \leq \varphi \leq 200^\circ$; and
 Zone 4: $\varphi = 200^\circ$ to 340° or $200^\circ \leq \varphi \leq 340^\circ$.

Figure 12C shows a coordinate system 1200C with a plurality of zones having different elevation coordinates in accordance with an example embodiment. By
10 way of example, three zones with different coordinates are shown. These zones include the following:

- Zone 1: $\varphi = 0^\circ$ to 45° or $0^\circ \leq \varphi \leq 45^\circ$;
 Zone 2: $\varphi = 45^\circ$ to 135° or $45^\circ \leq \varphi \leq 135^\circ$; and
 Zone 3: $\varphi = 135^\circ$ to 360° or $135^\circ \leq \varphi \leq 360^\circ$.

15

Figure 12D shows a coordinate system 1200D with a plurality of zones having different elevation coordinates in accordance with an example embodiment. By
way of example, three zones with different coordinates are shown. These zones include the following:

- 20 Zone 1: $\varphi = 0^\circ$ to 90° or $0^\circ \leq \varphi \leq 90^\circ$;
 Zone 2: $\varphi = 90^\circ$ to 180° or $90^\circ \leq \varphi \leq 180^\circ$; and
 Zone 3: $\varphi = 180^\circ$ to 360° or $180^\circ \leq \varphi \leq 360^\circ$.

Figure 12E shows a coordinate system 1200E with a plurality of zones having
25 different elevation coordinates in accordance with an example embodiment. By way of example, five zones with different coordinates are shown. These zones include the following:

- Zone 1: $\varphi = 336^\circ$ to 50° or $336^\circ \leq \varphi \leq 50^\circ$;
 Zone 2: $\varphi = 290^\circ$ to 336° or $290^\circ \leq \varphi \leq 336^\circ$;
30 Zone 3: $\varphi = 344^\circ$ to 50° or $344^\circ \leq \varphi \leq 50^\circ$;

Zone 4: $\varphi = 290^\circ$ to 344° or $290^\circ \leq \varphi \leq 344^\circ$; and

Zone 5: $\varphi = 325^\circ$ to 25° or $325^\circ \leq \varphi \leq 25^\circ$.

Consider a reclining user wearing a HMD with PHT and working at a virtual
5 workstation that displays the visual component of the tasks or work at hand such
as at a virtual monitor. The user provides input by voice command, gaze,
handheld pointing device, and/or other ways that do not require a desk or flat
surface (in contrast with a keyboard and mouse). Because the virtual monitor
placement is also not dependent on a desk, the visual component of the work is
10 displayed to the user at a more comfortable resting gaze elevation or more
natural or preferred line-of-sight. For example, to increase the working comfort of
the user and improve his or her performance, the gaze elevation of visual
material is centered around -24° from the horizontal when the user sits upright,
and centered around -16° from the horizontal when the user reclines.

15 Accordingly in this example, sound localization zones are defined to correspond
to the FOV or to virtual or physical displays or work areas of the reclined user
and upright user. The user designates that sound localization is confined to the
zone. This designation assists the user to focus on the work at hand in the zone
20 and eliminates distracting localizations outside the zone. Although the user
localizes sound outside his FOV or this zone, human error reduces and human
accuracy increases when the sound localization zone is confined to the field-of-
view of the user. For example, the HMD provides images or visual cues at the
coordinates of SLPs in order to minimize perceptual errors, such as front-back
25 flipping. These images or cues also reduce the size of the cone of confusion and
reduce difficulty in localizing sound to the median plane. Similarly, sound is
localized at images or visual events in order to highlight or draw the attention of
the user to the image of a point in space. The audio-visual cue combinations in
space or on a display reinforce overall perception and improve overall
30 functionality. Establishing such zones thus improves the functionality of the
workspace.

Consider the example of the reclining user wearing the HMD and viewing a virtual monitor. The user does not move his or her head (e.g., the user is supine, rests the head in a headrest, or is in a public place and prefers to keep the head stationary). In this case, the zones are limited to a FOV that is limited by the range of the gaze of the user because the head does not rotate. The HMD renders to the display only the portion of the virtual environment that corresponds to the single head orientation, and the SLS localizes sound only to the zone that matches the portion of the virtual environment. The experience of the user is improved by defining such zones that allow the user to operate in the VR space in which the accuracy of the sound localization is reliably increased.

Consider an example in which a user wears a HMD, keeps his head still, and sees a virtual monitor in a zone defined by a first FOV. The virtual monitor is in the zone. The user then rotates his head 120° to the left and sees a second FOV. The user cannot see the virtual monitor. The sound localization zone is defined in the frame of reference of the head so that when the head is rotated to the left, the zone also rotates to the left. The user hears localizations in the zone in front of him in the second FOV. The user no longer hears localizations at the virtual monitor 120° to his right in the first FOV. The zone defined this way in the reference frame of the head of the user is useful for localizing only sound in a current FOV, so a user only localizes sound occurring in locations he or she can see. For example, the user describes the effect of the localization zone as “tunnel vision, but for sound, with the size and shape of the tunnel being my FOV.”

Consider the example above in which the sound localization zone is defined in the reference frame of the virtual space and not the frame of reference of the head. In this example, when the head is rotated to the left, the zone does not rotate and remains at the first FOV. The zone does not move and still includes the virtual monitor. The user continues to hear sound localize at the virtual monitor 120° to the right, but does not hear sound localized in the second FOV in

front of him or her. The zone defined this way in the reference frame of the virtual space allows the user to monitor the sound localization at the first FOV and/or passively prompts the user to return their visual attention to the virtual monitor in the zone.

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Some of the figures and example embodiments provide specific numbers, such as specific numbers for coordinates of SLP and/or zones. Example embodiments include these specific numbers but also include approximations or “about” the specific numbers. For example, azimuth coordinates (θ) for a zone that are about or approximately equal to 0° to 90° would include values of θ for $\pm 3^\circ$ (i.e., plus or minus three degrees). Thus, $\theta = (357^\circ - 3^\circ)$ to $(87^\circ - 93^\circ)$ or from between -3° and 3° to between 87° and 93° .

Figures 11 and 12 provide example zones with azimuth and elevation coordinates. These figures can be combined in various combinations to generate example embodiments with zones of two or three dimensions expressed or defined by the combination. The following combinations include examples in accordance with an example embodiment: Figure 11A provides azimuth coordinates that can be combined with elevation coordinates of Figure 12A, 12B, 12C, 12D, or 12E. Figure 11B provides azimuth coordinates that can be combined with elevation coordinates of Figure 12A, 12B, 12C, 12D, or 12E. Figure 11C provides azimuth coordinates that can be combined with elevation coordinates of Figure 12A, 12B, 12C, 12D, or 12E. Figure 11D provides azimuth coordinates that can be combined with elevation coordinates of Figure 12A, 12B, 12C, 12D, or 12E. Figure 11E provides azimuth coordinates that can be combined with elevation coordinates of Figure 12A, 12B, 12C, 12D, or 12E. Furthermore, all zones from one figure do not have to be shared with all zones from another figure. One or more zones or angles from one figure can be shared or included with one or more zones or angles from another figure.

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Further, a zone defined by a combination can extend from an inner radius r_1 to an outer radius r_2 . Each r_1 and r_2 of these combinations can have a different or same value of distance (r). Examples of distance (r) include, but are not limited to, near-field values, far field values, 1.0 m or about 1.0 m, 1.1 m or about 1.1 m, 1.2 m or about 1.2 m, 1.3 m or about 1.3 m, 1.4 m or about 1.4 m, 1.5 m or about 1.5 m, 1.6 m or about 1.6 m, 1.7 m or about 1.7 m, 1.8 m or about 1.8 m, 1.9 m or about 1.9 m, 2.0 m or about 2.0 m, 2.1 m or about 2.1 m, 2.2 m or about 2.2 m, 2.3 m or about 2.3 m, 2.4 m or about 2.4 m, 2.5 m or about 2.5 m, 2.6 m or about 2.6 m, 2.7 m or about 2.7 m, 2.8 m or about 2.8 m, 2.9 m or about 2.9 m, 3.0 m or about 3.0 m, etc.

For example, combining zone 1 and zone 2 of 1100A with zone 1 of 1200A results in a combination defining two zones; a left zone from 270° to 0° azimuth and 0° to 30° elevation, and a right zone from 0° to 90° azimuth and 0° to 30° elevation. Additional zones are defined by specifying r_1 and r_2 . Consider a first example additional zone bounded by the left zone and extending from $r_1=1.0$ m to $r_2=2.0$ m. This zone has the shape of a rectangular frustum (the top and bottom of the frustum being curved surfaces). Consider an example additional zone that is a curved plane bounded by the right zone and with $r_1=3.0$ m (for an area zone r_2 is not specified, or $r_2=r_1$).

Figures 13A – 13E provide example configurations or shapes of zones in 3D space in accordance with example embodiments. For illustration, the configuration includes an origin or center that includes a user. For example, a head or body of the user is positioned at an origin of the configuration. Further, each configuration can include one or more zones or SLPs with a few being shown for illustration. Further yet, different configurations and/or shapes from different figures can be mixed together for example embodiments. Furthermore, as explained herein, zones can include one or more SLPs or can intentionally include no SLPs (e.g., representing an area or location where external sound localization does not occur to the user).

Figure 13A shows a sphere or spherical configuration 1300A with an origin 1310A that represents where a head or body of a user is located in accordance with example embodiments. The configuration 1300A can be divided into a plurality of SLPs and/or zones and include one or more different ways to divide a sphere. By way of example, the configuration is divided into or includes a plurality of frustoconical zones, two such zones being shown at 1320A and 1322A. Zone 1320A is a circular frustoconical zone located above a head of a user and includes one or more SLPs, and zone 1322A is an elliptical frustoconical zone located in front of the user and includes one or more SLPs. For example, zone 1322A is located directly in front of a face of the user or along a line-of-sight of the user, with a left side at 325°, a right side at 35°, an upper side at 25°, a lower side at 325°, and extending from 0.8 m to 1.2 m. The configuration 1300A can include zones with other shapes (e.g., other zones having a conical shape, circular shapes, curved shapes, partial or hemispherical shape, elliptical shapes, irregular shapes, groups of SLPs bunched or located together, a single SLP, or other shapes).

Figure 13B shows a partial sphere or hemi-spherical configuration 1300B with an origin 1310B that represents where a head or body of a user is located in accordance with example embodiments. The configuration 1300B can be divided into a plurality of SLPs and/or zones and include one or more different ways to divide a partial sphere or hemi-sphere. By way of example, the configuration is divided into or includes a plurality of spherical cross sections, two such zones being shown at 1320B and 1322B. Zone 1320B is located above a head of a user as a cap or top of the configuration and includes one or more SLPs, and zone 1322B is located around a head of the user and includes one or more SLPs. The configuration 1300B can include zones with other shapes (e.g., other zones having a pie shape, curved planar or curved surface shape, irregular shapes, groups of SLPs bunched or located together, a single SLP, or other shapes).

Figure 13C shows a cylinder or cylindrical configuration 1300C with an origin 1310C that represents where a head or body of a user is located in accordance with example embodiments. The configuration 1300C can be divided into a plurality of SLPs and/or zones and include one or more different ways to divide a cylinder. By way of example, the configuration is divided into or includes a plurality of horizontal and/or vertical cross sections of the cylinder, three example zones being shown at 1320C, 1322C, and 1324C. Zone 1320C is located above a head of a user and includes one or more SLPs; zone 1322C is located around a head of the user and includes one or more SLPs; and zone 1324C is located below the head of the user. The configuration 1300C can include zones with other shapes (e.g., other zones having a pie shape, a circle shape, a curved planar shape, a cylindrical shape, irregular shapes, groups of SLPs bunched or located together, a single SLP, or other shapes).

Figure 13D shows an irregular shaped configuration 1300D with an origin 1310D that represents where a head or body of a user is located in accordance with example embodiments. The configuration 1300D includes a plurality of SLPs and/or zones. By way of example, the configuration includes one or more SLPs that form a zone, such as a single SLP 1320D located above a head of the user and three bunches or groups of SLPs 1322D, 1324D, 1326D positioned away from the head of the user. For example, the group of SLPs 1324D define an arc-shaped zone.

Figure 13E shows an irregular shaped configuration 1300E with an origin 1310E that represents where a head or body of a user is located in accordance with example embodiments. The configuration 1300E includes a plurality of SLPs and/or zones. By way of example, the configuration includes one or more SLPs that form a cube-shaped zone 1320E located on a left side of a head of the user, a cube-shaped zone 1322E located on a right side of the head of the user, a curved planar zone 1324E located in front of a face of the user, a planar zone

1326E located to a left side and in front of the face of the user, and a planar zone 1328E located to a right side and in front of the face of the user.

In an example embodiment, zones can start and/or end at a definitive or specific location (e.g., a location defined per a coordinate system). Zones can also extend for an indefinite or undeterminable location. For example, a zone extends away from a listener for a distance equivalent to an edge of audible space of the listener, which can be different for individual listeners, and for different physical and virtual environments.

Some technical challenges with binaural sound include how to determine where to place the origin of the sounds (e.g., where to place the sound localization points for a listener). For example, when a user talks to another person on a VoIP telephone call, where should the computer system, electronic device, or software application place the voice of the person (In front of the listener? Beside the listener? At an object near the listener?). As another example, where should sounds be placed in physical or VR space? As yet another example, electronically generated binaural sound can be indistinguishable from sound originating in the physical environment of the user. Where or how should this binaural sound be placed so as not to surprise, startle, or confuse the listener? As another example, where should binaural sound be placed with respect to a listener when these sounds originate from different software applications, different origins, have unknown sound types, or unknown sources. Example embodiments solve many of the new technological challenges with binaural sound.

In one or more example embodiments, a software program (such as an intelligent user agent (IUA), a machine-learning user agent, or an intelligent personal assistant (IPA)) manages the binaural sound and makes decisions with regard to binaural sound. Such decisions include, but are not limited to, one or more of defining a size, a shape, a location, and/or a number of zones or sound

localization points (SLPs) around a head of listener; deciding what designations to make for each of the zones or SLPs (such as designating one zone or SLP for receiving calls, one zone or SLP for a virtual microphone point (VMP), one zone or SLP for audio warnings, one zone or SLP for a voice from an intelligent

5 personal assistant, one zone or SLP for messages, such as voice messages from humans or machines, etc.); deciding into which zone or SLP to place a voice or other sound (such as placing friends in one zone or SLP, business colleagues in another zone or SLP, music in another zone or SLP, alarms in another zone or SLP, etc.); deciding where to position a SLP for sound when

10 information about the sound is known or not known; deciding when to move a SLP for sound from one zone to another zone or from one SLP to another SLP; deciding when to turn on or turn off a SLP for sound; deciding when to switch sound among stereo sound, binaural sound, and mono sound; deciding what size or shape to make a zone or group of SLPs; deciding what volume of sound to

15 provide with a zone or SLP; deciding what path or trajectory to move or transition sound through 3D space around a user (such as moving a SLP of sound playing to a listener from one zone to another zone or through a zone); and executing example embodiments.

20 The software program acts on a decision or causes an action to occur with regard to the decision. For example, the IUA causes or assists in executing the decision, informs a user of the decision, informs other IUAs of the decision, informs a program or process of the decision, stores or transmits the decision, or executes example embodiments.

25 IUAs (or other software programs) share decisions and information with each other. By way of example, decisions or decision trees are stored in a database. The IUA compares a current decision or information for formulating a decision with stored decisions or previously executed decisions, and analyzes or weighs

30 the information to arrive at a designation for the SLP or zone. For instance, the IUA makes the decision based on collaborative data, the personal preferences of

the user, personal and/or private data in the user profile of the user, and other information. As more IUAs share data with each other, the more informed or better the decisions are for the users. The system builds models to assist in making decisions with regard to binaural sound and updates these models to
5 improve predictions and decision-making.

IUAs also form groups, such as two or more IUAs of different users aligning and sharing information with each other (e.g., two IUAs sharing sound localization information, selections of SLPs and/or zones where to place sound, assignments
10 or designations of types of sound and/or sources of sound to SLPs and/or zones, and other methods and blocks discussed herein). IUAs consult each other and assist each other in making informed decisions for their users. For instance, a group of IUAs and their experiences are collectively more intelligent than a single IUA. The groups are based on a commonality of the users and their preferences,
15 or based on a commonality of the IUAs (such as the IUAs having certain characteristics, features, personalities, etc.).

IUAs gather, analyze, and share data on localization, zones, and SLPs for users (including human users, software programs, and processes). This data includes,
20 but is not limited to, user preferences for where binaural sounds should be localized, at or on which objects binaural sounds should be localized, volumes for different binaural sounds, zone or SLP locations for different binaural sounds, distances from the listener for binaural sounds, and other information based on user preferences and past and present placement of sound localization points.
25 This data is stored in local or global user preferences that are shared among different intelligent user agents that serve different listeners.

Consider an example in which an IUA named Hal executes for a user named Alice. Alice wears her headphones when a home appliance sends her an audio
30 warning that the food in the oven is finished cooking. Hal intercepts the warning but does not know where to localize this sound to Alice. Hal consults with other

IUAs of other users that Alice does not know and determines that these other users prefer to have this warning localize at (1.0 m, 145°, 20°). Based on this collaborative information, Hal selects HRTFs to convolve the sound so the warning localizes to Alice at (1.0 m, 145°, 20°).

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An area around a user can be divided into multiple 1D, 2D or 3D areas or zones to where sound localizes to the user. These areas represent locations where a user perceives sound to originate or localize and include locations in empty space and locations occupied by physical objects. The number of zones, the size of the zones, the shape of the zones, the number of SLPs in a zone, and the location of the zones can vary. Further, this information can be predetermined (e.g., established per a convention, or an industry standard), or established by a user, electronic device, process, or software application, such as an IUA.

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The zones can be carved out or divided out from a larger zone. By way of example, a sphere (or partial sphere, such as a hemisphere) defines an area proximate to and around a head of a listener that is positioned within a center of the sphere. For instance, this sphere has a radius in a range from one foot or less to about six feet or more. This sphere is divided into a plurality of smaller spheres or other shapes (such as cones, truncated cones, cylinders, rectangles, etc.) that represent zones.

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As noted, zones can also have different sizes and shapes. For instance, one zone exists as a cone of confusion adjacent a left ear of the listener, and another zone of similar or same size and shape exists as a cone of confusion adjacent a right ear of the listener. For example, a zone exists in front of the user in the shape of a rectangular solid with a center of a vertical face being one meter from the user and the face extending from -35° to 35° azimuth and from -25° to 20° elevation. For example, a half-watermelon shape zone exists in front of the user, a first truncated cone exists along an azimuth from 30° to 45° at a right side of the user, a second truncated cone exists along an azimuth from -30° to -45° at a

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left side of the user, a cylindrical zone exists above a head of the listener, and a rectangular zone exists behind the listener. These shapes and locations provide an example illustration how an area around a person can be divided into zones of different sizes and shapes.

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Consider an example in which an area around a head of a user is divided into one or more of eight different zones as follows: zone 1 being inside a head of a user, zone 2 being above the ears of the listener (e.g., above a head of the listener), zone 3 being directly in front of a face of the listener, zone 4 being 45
10 degrees left of the face of the listener, zone 5 being 45 degrees right of the face of the listener, zone 6 being adjacent a left ear of the listener, zone 7 being adjacent a right ear of the listener, and zone 8 being behind a listener (such as being behind a head of the listener).

15 Sound localization points for different binaural sounds are placed in one of the multiple zones based on various factors, such as a GPS location of the listener, a type of sound, a meaning or purpose of the sound, a location of the sender of the sound, a software application that generates, provides, or transmits the sound, etc.

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Consider an example in which a SLP for a sound is placed in a zone based on a type of sound. The sound localization system (SLS) manages where the sounds are placed. The SLS retrieves head related transfer functions (HRTFs) so the sounds are convolved to localize in the selected SLP. For instance, the SLS
25 places voice recordings to play back in zone 1, places human voices in a VoIP telephone call in zone 3, places warnings or alerts in zone 8, places sound logos through several zones, etc.

IUAs choose a location to place a sound based on shared data along with
30 personal or private data of a listener (such as user preferences, historical or previous placements of sounds et al.). For example, the IUA determines a type of

incoming binaural sound and then makes an intelligent determination as where to place the localization point for this sound. This intelligent determination is based not only on historical preferences of the listener but also on historical preferences of other listeners under similar conditions. Thus, intelligent user agents

5 collectively share and refine information and learn as more users and more user preferences originate.

As explained herein, an area around a head or body of a listener is divided into different zones or SLPs with different physical/virtual sizes, shapes, and locations.

10 Each zone or each SLP is associated with a meaning or designation and tag that is different than another zone or another SLP. For example, a sound localizing in zone A has a different meaning to the listener than the same sound localizing in zone B. For instance, when the sound localizes in zone A, the sound implies or signifies a reminder or alert. When the same sound later localizes in zone B, the
15 sound implies a warning that requires immediate attention of the listener. The user, an application, or an IUA assigns labels or tags to zones or SLPs. For example, a property of the zones and SLPs (such as a field/column in the zone or SLP table) stores labels or tags. For example, the property is called "tags" and the user chooses to store as tags (in the tag property or field of the zone)
20 words associated with categories of information or types of sound. The user stores "personal" to the tag property of a zone close to his face, and stores "alerts" to the tag property of a zone above the head. The tag field includes zero, one, or multiple such words or labels. The labels are any data and are not limited to words, phrases, characters, strings, or ASCII. The labels have a
25 meaning or use to one or more users, IUAs, or applications, or no meaning or use.

Consider an example in which sounds appearing in zone 1 are VoIP calls, voice messages, SMS messages, and other telecommunications. Sounds appearing in
30 zone 2 are information (voice or other sounds) from machines, such as home appliances, motorized vehicles, etc. Sounds appearing in zone 3 are from an

intelligent personal assistant (such as the voice of Hal localizing into this zone). Sounds appearing in zone 4 are reminders for action items, such as calendar events, items from a To-Do list, etc. Sounds appearing in zone 5 are warnings or alerts. Sounds appearing in zone 6 are reserved for computer-generated sounds, such as a startup sound of an electronic device, a logo-sound or sound that identifies a company (such as “swish” sound that identifies ABC company to all listeners). Example embodiments are not limited to providing the sounds with these noted zones. Instead, the example is provided to illustrate that zones can be designated with sounds that have a particular meaning.

Multiple zones or multiple SLPs have a unique meaning. For example, a binaural sound that moves from zone A to zone D has a different meaning to the user than the same sound that moves from zone A to zone E. Binaural sounds traverse through multiple zones or SLPs in a predetermined pattern or sequence that provides the listener with a unique or predetermined meaning. The patterns or trajectories form geometric shapes, such as moving a sound through an S-shape, A-shape, arc-shape, swirling-shape, straight line shape, etc. The volume of the sound also changes as the sound moves through different zones or different SLPs, and this change in volume designates a particular meaning.

Consider an example in which a “swish” sound approaches a listener from his/her left side, passes through his/her head, and exits from a right side. This sound along with the pattern of its movement designates a special or certain meaning. Example meanings include, but are not limited to, ownership (such as a sound passing through certain SLPs designates a sound logo of a company or an application belonging to a certain company or owner), execution of a particular software application (such as sound passing through certain zones indicates to the listener a certain software application will execute or is executing), a particular action (such as sound commencing at one SLP and ending at a second SLP indicates a telephone call will commence or an IUA will speak, such as at the second SLP).

Consider an example of a sound sequence in which a sound of a virtual train approaches a user and gets louder as the virtual train approaches. When the virtual train arrives at the head of the user, the sound enters the user's head (e.g.,
5 as stereo or mono sound) and fades out. This sound sequence endures for about two seconds. Listeners recognize this sound as belonging to company ABC. When a listener hears this binaural sound, he or she knows that the software application being executed belongs to company ABC.

10 One challenge is that electronically generated or electronically provided binaural sound can emulate natural sound and in some instances be indistinguishable from natural sound. A listener can be confused or unable to determine whether a sound is an electronically generated binaural sound (electronic binaural sound) or a sound in the physical environment of the listener. This confusion or inability
15 to distinguish between real or natural binaural sounds (e.g., sounds occurring in a listener's physical environment) and electronic binaural sounds (e.g., binaural sounds provided to a user through an electronic device) is not desirable in many situations.

20 Example embodiments enable a user to distinguish between natural binaural sounds and electronic binaural sounds.

In one example embodiment, a predetermined sound plays to the user, and this sound indicates to the user that the sounds are electronic binaural sounds. For
25 example, a designated short sound (like a ping or other sound) informs the listener that the sounds the listener is hearing or the sounds the listener will be hearing are electronic binaural sounds. The listener understands that hearing the designated recognized sound signifies that sounds are electronic binaural sounds. This recognized sound is played periodically to remind the user, and/or
30 upon a certain event, such as playing the designated sound before the electronic binaural sound commences or periodically playing the designated sound while

the electronic binaural sound commences. Furthermore, this designated sound is played to localize to one or more external SLPs.

5 An example embodiment creates and/or reserves one or more zones for electronic binaural sound, such as regions where a user rarely hears sound from the physical environment. For example, a zone within the radius of the head of the user is a zone where physical environment sound is not heard without earphones. As another example, an example embodiment creates and/or reserves a zone above the head of the listener or a vertical cylindrical zone with
10 a radius of two meters, centered under the user and extending downward from the floor. An example embodiment defines a zone as the region in space that is occupied by a physical object, such as a computer monitor, a desk surface, an appliance, a piece of furniture, a wall, a ceiling, or a body. An example embodiment determines the region occupied by an object as discussed herein.

15 In one example embodiment, a listener is apprised of a sound being an electronic binaural sound based on where the sound externally localizes with respect to the listener. Certain sounds are assigned to certain zones or certain SLPs. When a sound appears in this zone or at this SLP, then this action indicates to the
20 listener that the sound is actually an electronic binaural sound.

Consider an example in which a user wears earphones that enable the user to hear both electronic binaural sound from the earphones and naturally occurring sound captured from the physical environment and amplified through the
25 earphones. The user would be unable to distinguish which sounds are natural and which sounds are electronically generated. The earphones, however, provide a short “ping” sound at the SLP or in the zone before the electronic binaural sound localizes to this SLP or this zone. When the user hears the ping, he or she knows that the next sound will be an electronic binaural sound. The
30 ping thus provides the user with an audio warning or audio notice that the sound is an electronic binaural sound. Alternatively, the audio alert indicates a sound

- from the physical environment. For example, a user engrossed in a computer game chooses to hear the localized sounds from the computer game without frequent audio alerts. The physical environment that he or she monitors has fewer sounds, so the user selects that the alerts will distinguish the sounds from
- 5 his physical environment. The functionality of the alert is improved because the user is more sensitive to the less frequent sound of the alerts. An example embodiment localizes an alert at the position of the audial event in the environment, at a designated SLP or zone for the alert, or at both places.
- 10 Consider further this example of the user wearing earphones. The user does not like to hear the “ping” sound and prefers to hear another sound instead. The user selects a different sound from his sound user preferences, and this newly selected sound plays as the alert sound.
- 15 The alert sound that indicates an electronically originating sound or that indicates a physical environment sound occurs before the sound plays or while the sound plays. For example, the device of the user caches the sound captured from the physical environment and delays the play of the sound in order to include an alert that indicates a naturally occurring sound. As another example, if electronic
- 20 binaural sound plays for an extended period of time, the user may forget that the sound playing is actually electronic binaural sound. The system sets the alert sound to play at predetermined intervals (such as playing the alert once every 30 seconds, once every minute, once every two minutes, once every three minutes, once every five minutes, etc.). A user establishes these intervals. A computer
- 25 program (e.g., an IUA) or a manufacturer also sets these intervals. As mentioned, the alert plays at the SLP of the electronic binaural sound and/or at a SLP or zone designated for the alert. Consider an example wherein the user designates a first alert sound in a first zone (e.g., a left side zone) to designate electronically originating sound and also designates a second alert sound in a second zone
- 30 (e.g., a right side zone) to indicate or highlight physical environment sound.

In an example embodiment, users or software programs select SLPs and zones and select the sounds that appear in these zones. For example, each user personalizes or customizes SLPs, zones, sound that localizes in the SLPs and zones, etc.

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In another example embodiment, SLPs and zones are standardized for multiple users. For example, manufacturers of home cooking appliances agree that warnings and alerts are to localize to users to one or more SLPs located in zone 4. This zone 4 is designated for these warnings and alerts. Other companies agree not to localize sounds to zone 4 except for sounds pertaining to cooking appliances issuing warnings or alerts. In this manner, zone 4 becomes a standard or a conventional location where listeners hear warnings and alerts for cooking appliances. When a user hears a sound in this zone 4, he or she immediately knows that this sound is a warning or an alert for a home cooking appliance.

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SLPs and zones represent locations where binaural sound can externally localize to the user. This binaural sound localizes to a SLP or zone that is in empty space (e.g., a location void of a tangible object) or localize to a SLP or zone that is occupied with a tangible object (e.g., localize to a location occupied with a real person or another type of physical object). Furthermore, in a VR world or AR world (e.g., when a user wears an OHMD), an empty space is occupied with a VR image or an AR image.

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Consider an example in which a listener receives a telephone call, and a voice of the caller localizes to a zone one meter directly in front of a face of the listener. This SLP is in empty space since no tangible object exists at the SLP located one meter in front of the listener. While remaining at this location, the listener dons and activates a head mounted display (HMD). The voice of the caller remains at the SLP, but the HMD displays an image of the caller at the SLP. The addition of the visual image of the caller at the SLP did not change the fact that

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the location one meter directly in front of the face of the listener is empty space. The listener sees an image at this location, but in reality the location is empty space.

- 5 This example illustrates that empty space can be void of a tangible object but at the same time include a VR or AR image to a user. The empty space, from the point-of-view of the listener can be occupied with a VR image or an AR image, such as an image occurring in a VR game or VR software application.
- 10 In one or more example embodiments, SLPs and/or zones can be separate from each other, can be distinct from each other, can be similar to each other, can share one or more common boundaries or borders, can have separate boundaries or borders, can have one or more overlapping regions or areas or SLPs, or can have no overlapping regions or areas or SLPs.
- 15 The zones and/or SLPs can be visible to a user. For example, the zones and/or SLPs can be viewed in VR or AR (e.g., with a HMD or another wearable electronic device). For instance, boundaries, perimeters, areas, volumes, lines, borders, overlaps, coordinates, points, etc. are presented with color, shading,
- 20 partial transparency, animated surfaces, or other visual indication to enable the user to see and determine SLP and zone locations.
- The zones and/or SLPs can be invisible to a user. For example, the user is not able to see zones and/or SLPs or their boundaries, areas, etc. With binaural
- 25 sound, however, the user can hear sounds externally localizing to different zones and/or SLPs. As such, in some example embodiments, a user determines a specific or general location of a zone based on hearing sounds localize inside and outside of the zone.
- 30 Figure 14 is a computer system or electronic system 1400 in accordance with an example embodiment. The computer system includes a portable electronic

device or PED 1402, one or more computers or electronic devices (such as one or more servers) 1404, storage or memory 1408, and a physical object with a tag or identifier 1409 in communication over one or more networks 1410.

5 The portable electronic device 1402 includes one or more components of computer readable medium (CRM) or memory 1420 (such as memory storing instructions to execute one or more example embodiments), a display 1422, a processing unit 1424 (such as one or more processors, microprocessors, and/or microcontrollers), one or more interfaces 1426 (such as a network interface, a graphical user interface, a natural language user interface, a natural user
10 interface, a phone control interface, a reality user interface, a kinetic user interface, a touchless user interface, an augmented reality user interface, and/or an interface that combines reality and virtuality), a sound localization system 1428, head tracking 1430, and a digital signal processor (DSP) 1432.

15

The PED 1402 communicates with wired or wireless headphones or earphones 1403 that include speakers 1440 or other electronics (such as microphones).

The storage 1408 includes one or more of memory or databases that store one
20 or more of audio files, sound information, sound localization information, audio input, SLPs and/or zones, software applications, user profiles and/or user preferences (such as user preferences for SLP/Zone locations and sound localization preferences), impulse responses and transfer functions (such as HRTFs, HRIRs, BRIRs, and RIRs), and other information discussed herein.

25

Physical objects with a tag or identifier 1409 include, but are not limited to, a physical object with memory, wireless transmitter, wireless receiver, integrated circuit (IC), system on chip (SoC), tag or device (such as a RFID tag, Bluetooth low energy, near field communication or NFC), bar code or QR code, GPS,
30 sensor, camera, processor, sound to play at a receiving electronic device, sound identification, and other sound information or location information discussed

herein.

The network 1410 includes one or more of a cellular network, a public switch telephone network, the Internet, a local area network (LAN), a wide area network
5 (WAN), a metropolitan area network (MAN), a personal area network (PAN), home area network (HAM), and other public and/or private networks.

Additionally, the electronic devices need not communicate with each other through a network. As one example, electronic devices couple together via one or more wires, such as a direct wired-connection. As another example, electronic
10 devices communicate directly through a wireless protocol, such as Bluetooth, near field communication (NFC), or other wireless communication protocol.

Electronic device 1404 (shown by way of example as a server) includes one or more components of computer readable medium (CRM) or memory 1460, a
15 processing unit 1464 (such as one or more processors, microprocessors, and/or microcontrollers), a sound localization system 1466, an audio convolver 1468, and a performance enhancer 1470.

The electronic device 1404 communicates with the PED 1402 and with storage
20 or memory 1480 that stores sound localization information (SLI) 1480, such as transfer functions and/or impulse responses (e.g., HRTFs, HRIRs, BRIRs, etc. for multiple users) and other information discussed herein. Alternatively or additionally, the transfer functions and/or impulse responses and other SLI can be stored in memory 1420.

25 Figure 15 is a computer system or electronic system in accordance with an example embodiment. The computer system 1500 includes an electronic device 1502, a server 1504, and a portable electronic device 1508 (including wearable electronic devices) in communication with each other over one or more networks
30 1512.

Portable electronic device 1502 includes one or more components of computer readable medium (CRM) or memory 1520, one or more displays 1522, a processor or processing unit 1524 (such as one or more microprocessors and/or microcontrollers), one or more sensors 1526 (such as micro-electro-mechanical systems sensor, an activity tracker, a pedometer, a piezoelectric sensor, a biometric sensor, an optical sensor, a radio-frequency identification sensor, a global positioning satellite (GPS) sensor, a solid state compass, gyroscope, magnetometer, and/or an accelerometer), earphones with speakers 1528, a sound localization information (SLI) 1530, an intelligent user agent (IUA) and/or intelligent personal assistant (IPA) 1532, sound hardware 1534, a prefetcher and/or preprocessor 1536, and a SLP and/or zone selector 1538.

Server 1504 includes computer readable medium (CRM) or memory 1550, a processor or processing unit 1552, and a SLP and/or zone selector 1554.

Portable electronic device 1508 includes computer readable medium (CRM) or memory 1560, one or more displays 1562, a processor or processing unit 1564, one or more interfaces 1566 (such as interfaces discussed herein), sound localization information 1568 (e.g., stored in memory), a sound localization point (SLP) selector and/or zone selector 1570, user preferences 1572, one or more digital signal processors (DSP) 1574, one or more of speakers and/or microphones 1576, a performance enhancer 1581, head tracking and/or head orientation determiner 1577, a compass 1578, and inertial sensors 1579 (such as an accelerometer, a gyroscope, and/or a magnetometer).

A sound localization point (SLP) selector and/or zone selector includes specialized hardware and/or software to execute example embodiments that select a SLP and/or zone for where binaural sound localizes to a user.

A performance enhancer, prefetcher, and preprocessor are examples of specialized hardware and/or software that assist in improving performance of a

computer and/or execution of a method discussed herein and/or one or more blocks discussed herein. Example functions of a performance enhancer are discussed in connection with Figures 8 and 9.

5 A sound localization system (SLS) includes one or more of a processor, microprocessor, controller, memory, specialized hardware, and specialized software to execute one or more example embodiments (including one or more methods discussed herein and/or blocks discussed in a method). By way of example, the hardware includes a customized integrated circuit (IC) or
10 customized system-on-chip (SoC) to select, assign, and/or designate a SLP and/or zone for sound or convolve sound with SLI to generate binaural sound. For instance, an application-specific integrated circuit (ASIC) or a structured ASIC are examples of a customized IC that is designed for a particular use, as opposed to a general-purpose use. Such specialized hardware also includes
15 field-programmable gate arrays (FPGAs) designed to execute a method discussed herein and/or one or more blocks discussed herein. For example, FPGAs are programmed to execute selecting, assigning, and/or designating SLPs and/or zones for sound or convolving, processing, or preprocessing sound so the sound externally localizes to the listener.

20

The sound localization system performs various tasks with regard to managing, generating, interpolating, extrapolating, retrieving, storing, and selecting SLPs and can function in coordination with and/or be part of the processing unit and/or DSPs or can incorporate DSPs. These tasks include generating audio impulses,
25 generating audio impulse responses or transfer functions for a person, dividing an area around a head of a person into zones or areas, determining what SLPs are in a zone or area, mapping SLP locations and information for subsequent retrieval and display, selecting SLPs and/or zones for a user, selecting sets of SLPs according to circumstantial criteria, selecting objects to which sound will
30 localize to a user, designating a sound type, audio segment, or sound source to a SLP, generating user interfaces with binaural sound information, detecting

binaural sound, detecting human speech, isolating voice signals from sound such as the speech of a person who captures binaural sound by wearing microphones at the left and right ear, and executing one or more other blocks discussed herein. The sound localization system can also include a sound convolving
5 application that convolves and deconvolves sound according to one or more audio impulse responses and/or transfer functions based on or in communication with head tracking.

By way of example, an intelligent personal assistant or intelligent user agent is a
10 software agent that performs tasks or services for a person, such as organizing and maintaining information (such as emails, messaging (e.g., instant messaging, mobile messaging, voice messaging, store and forward messaging), calendar events, files, to-do items, etc.), initiating telephony requests (e.g., scheduling, initiating, and/or triggering phone calls, video calls, and telepresence
15 requests between the user, IPA, other users, and other IPAs), responding to queries, responding to search requests, information retrieval, performing specific one-time tasks (such as responding to a voice instruction), file request and retrieval (such as retrieving and triggering a sound to play), timely or passive data collection or information gathering from persons or users (such as querying
20 a user for information), data and voice storage, management and recall (such as taking dictation, storing memos, managing lists), memory aid, reminding of users, performing ongoing tasks (such as schedule management and personal health management), and providing recommendations. By way of example, these tasks or services can be based on one or more of user input, prediction, activity
25 awareness, location awareness, an ability to access information (including user profile information and online information), user profile information, and other data or information.

By way of example, the sound hardware includes a sound card and/or a sound
30 chip. A sound card includes one or more of a digital-to-analog (DAC) converter, an analog-to-digital (ATD) converter, a line-in connector for an input signal from a

sound source, a line-out connector, a hardware audio accelerator providing hardware polyphony, and one or more digital-signal-processors (DSPs). A sound chip is an integrated circuit (also known as a “chip”) that produces sound through digital, analog, or mixed-mode electronics and includes electronic devices such as one or more of an oscillator, envelope controller, sampler, filter, and amplifier. The sound hardware can be or include customized or specialized hardware that processes and convolves mono and stereo sound into binaural sound.

By way of example, a computer and an portable electronic device include, but are not limited to, handheld portable electronic devices (HPEDs), wearable electronic glasses, watches, wearable electronic devices (WEDs) or wearables, smart earphones or hearables, voice control devices (VCD), voice personal assistants (VPAs), network attached storage (NAS), printers and peripheral devices, virtual devices or emulated devices (e.g., device simulators, soft devices), cloud resident devices, computing devices, electronic devices with cellular or mobile phone capabilities, digital cameras, desktop computers, servers, portable computers (such as tablet and notebook computers), smartphones, electronic and computer game consoles, home entertainment systems, digital audio players (DAPs) and handheld audio playing devices (example, handheld devices for downloading and playing music and videos), appliances (including home appliances), head mounted displays (HMDs), optical head mounted displays (OHMDs), personal digital assistants (PDAs), electronics and electronic systems in automobiles (including automobile control systems), combinations of these devices, devices with a processor or processing unit and a memory, and other portable and non-portable electronic devices and systems (such as electronic devices with a DSP).

The SLP/zone selector and/or SLS can also execute predictions including, but not limited to, predicting an action of a user, predicting a location of a user, predicting an event, predicting a desire or want of a user, predicting a query of a user (such as a query to an intelligent personal assistant), predicting and/or

recommending a SLP, zone, or RIR/RTF or an object to a user, etc. Such predictions can also include predicting user actions or requests in the future (such as a likelihood that the user or electronic device localizes a type of sound to a particular SLP or zone). For instance, determinations by a software application, an electronic device, and/or user agent can be modeled as a prediction that the user will take an action and/or desire or benefit from moving or muting an SLP, changing a zone, from delaying the playing of a sound, from a switch between binaural, mono, and stereo sounds or a change to binaural sound (such as pausing binaural sound, muting binaural sound, selecting an object at which to localize sound, reducing or eliminating one or more cues or spatializations or localizations of binaural sound). For example, an analysis of historical events, personal information, geographic location, and/or the user profile provides a probability and/or likelihood that the user will take an action (such as whether the user prefers a particular SLP or zone as the location for where sound will localize, prefers binaural sound or stereo, or mono sound for a particular location, prefers a particular listening experience, or a particular communication with another person or an intelligent personal assistant). By way of example, one or more predictive models execute to predict the probability that a user would take, determine, or desire the action. The predictor also predicts future events unrelated to the actions of the user, such as the prediction of the times, locations, SLP positions, type or quality of sound, sound source, or identities of incoming callers or requests for sound localizations to the user.

Example embodiments are not limited to HRTFs but also include other sound transfer functions and sound impulse responses including, but not limited to, head related impulse responses (HRIRs), room transfer functions (RTFs), room impulse responses (RIRs), binaural room impulse responses (BRIRs), binaural room transfer functions (BRTFs), headphone transfer functions (HPTFs), etc.

Examples herein can take place in physical spaces, in computer rendered spaces (such as computer games or VR), in partially computer rendered spaces

(AR), and in combinations thereof.

The processor unit includes a processor (such as a central processing unit, CPU, microprocessor, microcontrollers, field programmable gate arrays (FPGA), application-specific integrated circuits (ASIC), etc.) for controlling the overall operation of memory (such as random access memory (RAM) for temporary data storage, read only memory (ROM) for permanent data storage, and firmware). The processing unit and DSP communicate with each other and memory and perform operations and tasks that implement one or more blocks of the flow diagrams discussed herein. The memory, for example, stores applications, data, programs, algorithms (including software to implement or assist in implementing example embodiments) and other data.

Consider an example embodiment in which the SLS or portions of the SLS include an integrated circuit FPGA that is specifically customized, designed, configured, or wired to execute one or more blocks discussed herein. For example, the FPGA includes one or more programmable logic blocks that are wired together or configured to execute combinational functions for the SLS, such as assigning types of sound to SLPs and/or zones, assigning software applications to SLPs and/or zones, selecting a SLP and/or zone for sound to externally localize as binaural sound to the user, etc.

Consider an example in which the SLS or portions of the SLS include an integrated circuit or ASIC that is specifically customized, designed, or configured to execute one or more blocks discussed herein. For example, the ASIC has customized gate arrangements for the SLS. The ASIC can also include microprocessors and memory blocks (such as being a SoC (system-on-chip) designed with special functionality to execute functions of the SLS).

Consider an example in which the SLS or portions of the SLS include one or more integrated circuits that are specifically customized, designed, or configured

to execute one or more blocks discussed herein. For example, the electronic devices include a specialized or custom processor or microprocessor or semiconductor intellectual property (SIP) core or digital signal processor (DSP) with a hardware architecture optimized for convolving sound and executing one or more example embodiments.

Consider an example in which the HPED includes a customized or dedicated DSP that executes one or more blocks discussed herein (including processing and/or convolving sound into binaural sound). Such a DSP has a better power performance or power efficiency compared to a general-purpose microprocessor and is more suitable for a HPED, such as a smartphone, due to power consumption constraints of the HPED. The DSP can also include a specialized hardware architecture, such as a special or specialized memory architecture to simultaneously fetch or pre-fetch multiple data and/or instructions concurrently to increase execution speed and sound processing efficiency. By way of example, streaming sound data (such as sound data in a telephone call or software game application) is processed and convolved with a specialized memory architecture (such as the Harvard architecture or the Modified von Neumann architecture). The DSP can also provide a lower-cost solution compared to a general-purpose microprocessor that executes digital signal processing and convolving algorithms. The DSP can also provide functions as an application processor or microcontroller.

Consider an example in which a customized DSP includes one or more special instruction sets for multiply-accumulate operations (MAC operations), such as convolving with transfer functions and/or impulse responses (such as HRTFs, HRIRs, BRIRs, et al.), executing Fast Fourier Transforms (FFTs), executing finite impulse response (FIR) filtering, and executing instructions to increase parallelism.

Consider an example in which the DSP includes the SLP selector and/or an

audio diarization system. For example, the SLP selector, audio diarization system, and/or the DSP are integrated onto a single integrated circuit die or integrated onto multiple dies in a single chip package to expedite binaural sound processing.

5

Consider an example in which the DSP additionally includes a voice recognition system and/or acoustic fingerprint system. For example, an audio diarization system, acoustic fingerprint system, and a MFCC/GMM analyzer and/or the DSP are integrated onto a single integrated circuit die or integrated onto multiple dies

10 in a single chip package to expedite binaural sound processing.

Consider another example in which HRTFs (or other transfer functions or impulse responses) are stored or cached in the DSP memory or local memory relatively close to the DSP to expedite binaural sound processing.

15

Consider an example in which a smartphone or other PED includes one or more dedicated sound DSPs (or dedicated DSPs for sound processing, image processing, and/or video processing). The DSPs execute instructions to convolve sound and display locations of zones/SLPs for the sound on a user interface of the HPED. Further, the DSPs simultaneously convolve multiple SLPs to a user.

20 These SLPs can be moving with respect to the face of the user so the DSPs convolve multiple different sound signals and sources with HRTFs that are continually, continuously, or rapidly changing.

25 As discussed, SLI includes multiple types of information to provide the computer system or electronic system data that localizes sound to a user. Managing the multiple information required to localize sound and managing the resources to obtain the information pose a challenge to providing users and software applications with a convenient way to localize sound. In some cases, a minimal

30 amount of SLI is required to localize sound (e.g., an ITD and a sound). In other cases, more SLI is required to localize sound, such as multiple types of

information (e.g., user specific HRTFs, a SLP trajectory, BRIRs, zones, remote sound data that streams). How can a user or software application determine which resources are needed for an intended localization? How and where can the resources be accessed and/or stored? How can the resources be shared in a cohesive way?

An example embodiment addresses these problems and provides solutions that improve functionality for listeners and software applications that process localizations.

10

Figure 16 is an example of sound localization information in the form of a file in accordance with an example embodiment.

The SLI can be packaged as a standard file format. For example, the file format is a sound localization information file that stands apart from sound data, or the file format is an audio file format that includes the sound that is localized.

Figure 16 shows an example sound localization file 1600 that includes a header 1612, SLI data 1614, and a sound for localization 1620. The example SLI file 1600 is a single file that includes multiple SLI resources and/or references or pointers to the resources. The file header 1612 includes an identification of the type of file that it is (an SLI file), a header format definition and/or checksum, a version number of the file type, an offset to the binary sound that is included in the file, and other data indicated by the header format.

25

The file identification provides an identity of the file type as the SLI file type. The file identification is located at the top or beginning of the file so that the file identification is encountered first or early in a sequential reading of the file. The header format or definition provides information about the header 1612, such as providing a header length, information to delimit the header, the information format of the header, and/or other information to orient the user or software

30

application accessing the SLI file 1600 in the navigation of and information included in the header 1612. The version number indicates the version of the file format to assist the user or software application in knowing the composition and layout of the SLI file 1600. The offset to the binary sound data included in the sound data 1620 allows a software application to skip to the reading of the binary sound data. For example, the software application is a media player, other software application, or electronic device that is not able to process localization, but is able to play the sound data without localization. The media player reads forward in the SLI file 1600 by the value of the offset and then reads and plays the binary sound data found there. As another example, the software application is a media player that processes the SLI file 1600 to localize to the user and the player reads both the SLI data 1614 and the binary sound data simultaneously to expedite the localization. Other information is included in the header 1612 to orient the user or software application accessing the SLI file in the navigation of and information included in the SLI file 1600.

The SLI data 1614 includes designation of the location in space where the sound is to be localized. For example, the location is a static SLP, such as is shown expressed in the "<sound paths>" tag as (1.1, 45, -10) indicating that the localization of sound 1620 should occur at (1.1 m, 45°, -10°) for the duration of the localization. As another example, the SLP of the sound 1620 moves and the location expresses a time-based trajectory or function of time (t) (e.g., shown as "(1.9, t, t)"). The SLI data 1614 specifies multiple sound paths for the sound including a default sound path, a reference origin for the sound path coordinates, and one or more frames of reference of the sound paths.

The SLI data 1614 includes one or more HRTFs such as the HRTF of a user shown within the "<HRTFS>" tag. An HRTF1 labels an HRTF of a user Alice including a lookup table with the HRTF pairs, other HRTF1 info, and a pointer to an alternative resource for the HRTF1 data (a filename, "Alice.AES69"). A software application processing the SLI file 1600 and/or SLI data 1614 has the

option to load and/or parse the HRTF1 data from the lookup table or fetch the HRTF1 data from the alternative resource. For example, the lookup table is corrupted so the software application executing the SLI file 1600 retrieves the HRTF1 data from Alice.AES69 instead of from the lookup table. As another
5 example, the software application reading the SLI file 1600 identifies from the alternative resource name that HRTF1 is already loaded or cached, so the software application reading the SLI file 1600 skips the reading of the lookup table. The SLI info also includes one or more other transfer functions, such as room transfer functions or binaural room transfer functions. The transfer functions
10 are stored as text to improve functionality for a user and/or stored in an encoded or other machine-readable format for expedited reading by the software application accessing the SLI file 1600 to provide improved performance.

The SLI info 1614 includes a pointer to an alternative resource for the sound
15 1620, such as a URL or filename for a sound file in a different storage location. A software application processing the SLI file 1600 and/or SLI data 1614 has the option to load the sound from the sound data 1620 and/or fetch the sound from the alternative resource. For example, the binary sound data of the sound 1620 is corrupted, and the computed checksum does not match the checksum 1622,
20 so the software application retrieves the sound from the alternative resource. As another example, the software application reading the SLI file 1600 identifies from the alternative resource name or the sound data 1620 that the sound is already stored locally, loaded, or cached, so software application skips the reading of the binary sound data. As another example, the alternative resource
25 is a sound stream of undetermined length, and the sound 1620 is the first or beginning part of the sound stream. The software application processing the SLI file 1600 immediately loads the binary sound data for playing, while caching the sound stream. This improves performance by expediting the localization. The sound is stored as a character block to improve functionality for a user and/or in
30 binary format for expedited reading by software application to provide improved performance.

Consider an example of a SLI file format identified with a file extension of ".SLI" and/or a unique file identification code in the first field or bytes of a header of the file. Such an SLI file is assembled with a hybrid or combination of a text-based markup language (e.g., extensible markup language (XML) or YAML (YAML Ain't Markup Language)) to support object definitions and/or objects, together with a format that supports binary data and component or object nesting (e.g. Resource Interchange File Format (RIFF)). This example format provides including as human readable some localization information and storing other SLI as binary data sets. Both formats are stored together in order to provide a number of improvements.

A media player application recognizing the SLI file format parses the SLI from the SLI file 1600 and applies the localization information 1614 to the sound 1620 at or before the time of playing of the sound 1620. A sound-playing application that does not recognize the SLI data 1614 ignores the SLI data 1614 and plays the sound 1620 without localization.

The option to load as chunks both sound data 1620 and other SLI data 1614 (e.g., encoded lookup tables such as HRTFs) from a single resource improves the performance of a player application. A savings in load time of the bulk data in binary form also improves the performance. Further, the human readable form of the SLI data 1614 allows other applications and users, including humans, to read and/or alter the SLI data 1614 and/or the sound 1620. This improves the functionality of sound localization for the user, other users, and applications. For example, an SLI component such as HRTFs are stored as textual data to improve the functionality for users, and/or stored as encoded data to improve the access performance for software applications. Additionally, by encapsulating the sound 1620 with the SLI data 1614 in a single file, software applications processing the SLI file that would otherwise be required to manage multiple resources separately (such as sound data, localization designations, and HRTF

pairs) are relieved of the processing of the management of the resources, improving overall performance. For example, a media player commanded to play a sound localization stored remotely opens one connection to the remote storage to retrieve the SLI file 1600 rather than requiring multiple sessions to retrieve multiple localization resource files. After the playing, a single SLI playing task, and a single file (SLI file 1600) are disposed, so that a single disposal task triggers the closure and/or clean-up of multiple resource allocations.

Figure 17 is an example of a sound localization information configuration in accordance with an example embodiment.

Figure 17 shows a sound localization information configuration 1700 that includes a sound localization information file 1710 that does not include a sound to localize. The sound file 1720 that localizes to the user and a positional information feed 1730 are stored in separate files or retrieved from separate locations. The SLI file 1710 includes a header 1712, SLI data 1714, and a SLI file checksum 1716. The header 1712 includes information about the SLI file 1710 as discussed regarding header 1612. The SLI data 1714 includes a resource link to transfer functions as discussed regarding SLI data 1614. The SLI data 1714 does not include a designation of the location in space where the sound is to be localized, and instead includes a pointer to an alternative resource for positional designation (shown as "IoT://Hal/position.feed"). The alternative resource provides a positional information feed 1730 that includes localization designation, such as SLP or HRTF coordinates and a timecode corresponding to the time at which the sound should be localized to a corresponding location. The SLI data 1714 includes a link to a sound resource (shown as "IoT://Hal/voice.wav"), the sound resource or sound file shown as 1720. Although the SLI file 1710 does not include sound data, positional data, or means to localize sound (e.g., HRTFs), a software application reading the SLI file 1710 finds in the SLI file 1710 complete information for executing a specific localization of a specific sound to a specific user.

Consider an example in which a software application executes on the HPED or phone of Alice and provides the voice output of an IPA named Hal. The software application uses SLI file 1710 to direct the localization of the voice of Hal. Alice

5 preconfigures the SLI file 1710 with a pointer to her HRTFs (shown as “http://cmatter.com/Alice.AES69”). The software application includes instructions that execute to open the SLI file 1710, to read-in the file contents, to calculate a checksum, and to confirm that the calculated checksum matches the SLI file checksum 1716. The software application further executes to parse the tags in

10 the file to identify paths to the sound file 1720, the HRTF file, and the positional information feed 1730, and to open connections to the sound file 1720 and the positional feed 1730. The software application examines the pointer or file path to the HRTFs and recognizes that the HRTFs are already cached so the application is not required to retrieve the HRTF file again. These actions improve computer

15 performance since the cached data saves time in retrieving the HRTF file and loading the file to memory.

The software application also discovers from the header received from the sound file 1720 that the sound resource is a sound stream. The software application

20 proceeds to execute the localization of the voice of Hal to Alice at the coordinates specified by Hal from moment to moment. The software application receives the voice of Hal from the sound resource 1720 at $t=0$, and receives or retrieves from the positional feed 1730 the coordinates for the present moment $t=0$ (1.3m, 9° , 0°). The software application parses the SLI data 1714 and retrieves the

25 reference frame (shown as “head center”) and origin (0, 0° , 0°) specified for the localization. The software application requests the OS of the HPED to convolve the sound source of the voice of Hal to the SLP at (1.3m, 9° , 0°) relative to a point (0, 0° , 0°) at the center of the head of Alice, using the corresponding HRTFs from the file Alice.AES69. The OS forwards these particular SLI in a request to

30 the SLS for localization. The SLS recognizes the sound source (the voice of Hal) as one that is allowed, recognizes the HRTF file as allowed, and requests the

SLP coordinates from the SLP selector. The SLP selector confirms that (1.3m, 9°, 0°) is an available SLP and confirms that the zones that include at (1.3m, 9°, 0°) do not prohibit the sound source (Hal) and do not prohibit the sound type of voice. The SLP selector approves the localization request, and this approval
5 triggers the SLS to allow convolution. The SLS directs the convolver to convolve the voice of Hal to (1.3m, 9°, 0°) with Alice's HRTFs. The voice of the IPA Hal originates to Alice at (1.3m, 9°, 0°).

The SLI file provides additional functionality to the user. For example, to
10 experience the localization again, the user issues a single command to trigger the execution of the localization. The "self-contained" nature of the SLI file that includes both SLI and sound (or links to their resources) improves the functionality for transmission and sharing of the sound localization to other locations and/or users or software applications. For example if another user
15 shares compatibility (can experience localization) with the same HRTFs of the first user, then the first user can easily share the localization experience with the other user by sending a single file to the other user. As another significant functionality improvement, human readability of the format aids alteration of the file. For example the user edits the human readable portion of the SLI file, finds
20 the HRTF component, and pastes or replaces the HRTF data with that of a third user. The user can send the altered file with the new HRTF data to the third user and know that the third user will experience the same localization that the user experienced. This robust functionality also permits assigning a localization of one sound to another sound, by replacing the sound component of the file, or
25 replacing or inserting the SLI component(s) into the SLI section of another SLI sound file.

Some SLI or SLI files include no SLPs/zones or location designations or links to their alternative provision. For example, a media player that executes localization
30 according to an SLI file parses the SLI file and cannot retrieve an SLP or sound path or an alternative resource of location designation information. The media

player takes another action as designated in the SLI file header, such as playing the sound without executing localization, not playing the sound, playing the sound with a default localization, a recent or cached localization, or a localization that indicates a failure to find the SLP.

5

Some SLI or SLI files include no transfer functions or impulse responses or other information for adjusting audial cues, and no pointers to alternative resource locations for them. For example, a media player that executes localization specified by an SLI file parses the SLI file and does not locate an HRTF. The

10 media player takes another action as designated in the SLI file header, such as playing the sound without executing localization, not playing the sound, executing the localization by adjusting other audial cues (e.g., ITD/ILD), or playing an alert sound.

15 For example a media player that executes localization for an SLI file parses the SLI file and does not identify sound data or a link to a sound. The media player examines the header file to determine a next action, such as playing an alert, halting the execution of the SLI file, playing a default sound or retrieving and playing the sound from a default file link.

20

In some example embodiments, the methods illustrated herein and data and instructions associated therewith, are stored in respective storage devices that are implemented as computer-readable and/or machine-readable storage media, physical or tangible media, and/or non-transitory storage media. These storage

25 media include different forms of memory including semiconductor memory devices such as NAND flash non-volatile memory, DRAM, or SRAM, Erasable and Programmable Read-Only Memories (EPROMs), Electrically Erasable and Programmable Read-Only Memories (EEPROMs), solid state drives (SSD), and flash memories; magnetic disks such as fixed and removable disks; other
30 magnetic media including tape; optical media such as Compact Disks (CDs) or Digital Versatile Disks (DVDs). Note that the instructions of the software

discussed above can be provided on computer-readable or machine-readable storage medium, or alternatively, can be provided on multiple computer-readable or machine-readable storage media distributed in a large system having possibly plural nodes. Such computer-readable or machine-readable medium or media is
5 (are) considered to be part of an article (or article of manufacture). An article or article of manufacture can refer to a manufactured single component or multiple components.

Blocks and/or methods discussed herein can be executed and/or made by a
10 user, a user agent (including machine learning agents and intelligent user agents), a software application, an electronic device, a computer, firmware, hardware, a process, a computer system, and/or an intelligent personal assistant. Furthermore, blocks and/or methods discussed herein can be executed automatically with or without instruction from a user.

15 The methods in accordance with example embodiments are provided as examples, and examples from one method should not be construed to limit examples from another method. Tables and other information show example data and example structures; other data and other database structures can be
20 implemented with example embodiments. Further, methods discussed within different figures can be added to or exchanged with methods in other figures. Further yet, specific numerical data values (such as specific quantities, numbers, categories, etc.) or other specific information should be interpreted as illustrative for discussing example embodiments. Such specific information is not provided
25 to limit example embodiments.

As used herein, the word “about” indicates that a number, amount, time, etc. is close or near something. By way of example, for spherical or polar coordinates of a SLP and/or zone (r, θ, ϕ) , the word “about” means plus or minus ($\pm$) three
30 degrees for θ and ϕ and plus or minus 5% for distance (r) .

As used herein, “distinct” means different in a way that you can see or hear. For example, SLP 1 is distinct from SLP 2 when a listener can audibly determine that the location of sound originates from two different locations that are externally located away from the listener.

5

As used herein, a “telephone call,” or a “phone call” is a connection over a wired and/or wireless network between a calling person or user and a called person or user. Telephone calls can use landlines, mobile phones, satellite phones, HPEDs, voice personal assistants (VPAs), computers, and other portable and non-portable electronic devices. Further, telephone calls can be placed through one or more of a public switched telephone network, the internet, and various types of networks (such as Wide Area Networks or WANs, Local Area Networks or LANs, Personal Area Networks or PANs, Campus Area Networks or CANs, etc.). Telephone calls include other types of telephony including Voice over Internet Protocol (VoIP) calls, internet telephone calls, in-game calls, telepresence, etc.

10

15

As used herein, “empty space” is a location that is not occupied by a tangible object.

20

As used herein, “field-of-view” is the observable world that is seen at a given moment. Field-of-view includes what a user sees in a virtual or augmented world (e.g., what the user sees while wearing a HMD).

25

As used herein, “proximate” means near. For example, a sound that localizes proximate to a listener occurs within two meters of the person.

As used herein, “separate” means not joined or physically touching. For example, Zone A and Zone B have separate azimuth coordinates if Zone A has azimuth coordinates of $0^\circ \leq \theta \leq 30^\circ$ and Zone B has azimuth coordinates of $90^\circ \leq \theta \leq 180^\circ$.

30

As used herein, “similar” means having characteristics in common but not being the same or identical.

- 5 As used herein, “sound localization information” is information that is used to process or convolve sound so the sound externally localizes as binaural sound to a listener.

- As used herein, a “sound localization point” or “SLP” is a location where a
10 listener localizes sound. A SLP can be internal (such as monaural sound that localizes inside a head of a listener), or a SLP can be external (such as binaural sound that externally localizes to a point or an area that is away from but proximate to the person or away from but not near the person). A SLP can be a single point such as one defined by a single pair of HRTFs or a SLP can be a
15 zone or shape or volume or general area. Further, in some instances, multiple impulse responses or transfer functions can be processed to convolve sounds to a place within the boundary of the SLP. In some instances, a SLP may not have access to a particular HRTF necessary to localize sound at the SLP for a particular user, or a particular HRTF may not have been created. A SLP may not
20 require a HRTF in order to localize sound for a user, such as an internalized SLP, or a SLP may be rendered by adjusting an ITD and/or ILD or other human audial cues.

- As used herein, “three-dimensional space” or “3D space” is space in which three
25 values or parameters are used to determine a position of an object or point. For example, binaural sound can localize to locations in 3D space around a head of a listener. 3D space can also exist in virtual reality (e.g., a user wearing a HMD can see a virtual 3D space).

- 30 As used herein, a “user” or a “listener” is a person (i.e., a human being). These terms can also be a software program (including an IPA or IUA), hardware (such

as a processor or processing unit), an electronic device or a computer (such as a speaking robot or avatar shaped like a human with microphones in its ears).

As used herein, a “user agent” is software that acts on behalf of a user. User
5 agents include, but are not limited to, one or more of intelligent user agents
and/or intelligent electronic personal assistants (IPAs, VPAs, software agents,
and/or assistants that use learning, reasoning and/or artificial intelligence), multi-
agent systems (plural agents that communicate with each other), mobile agents
(agents that move execution to different processors), autonomous agents
10 (agents that modify processes to achieve an objective), and distributed agents
(agents that execute on physically distinct electronic devices).

As used herein, a “zone” is a portion of a 1D, 2D or 3D region that exists in 3D
space with respect to a user. For example, 3D space proximate to a listener or
15 around a listener can be divided into one or more 1D, 2D, 3D and/or point or
single coordinate zones. As another example, 3D space in virtual reality can be
divided into one or more 1D, 2D, 3D and/or point zones.

CLAIMS

What is claimed is:

1. A method executed by one or more electronic devices in a computer system that determines a three-dimensional (3D) zone where binaural sound externally localizes to a listener and that provides the binaural sound to the listener so the binaural sound localizes in the 3D zone, the method comprising:

dividing a 3D space around a head of the listener into multiple separate 3D zones that are away from the head of the listener such that each of the multiple separate 3D zones includes sound localization points (SLPs) where binaural sounds localize to the listener;

assigning software applications that generate sound to different ones of the multiple separate 3D zones;

receiving, from one of the software applications, sound to externally localize in empty space away from the head of the listener and inside one of the multiple separates 3D zones;

determining a 3D zone to which the software application is assigned to externally localize the sound to the listener;

convolving, with a digital signal processor, the sound with head related transfer functions (HRTFs) of the listener to produce the binaural sound that localizes to a SLP located inside the 3D zone; and

providing, through electronic earphones in the computer system, the binaural sound that localizes to the listener at the SLP that is in the empty space away from the head of the listener and located inside the 3D zone.

2. The method executed by the one or more electronic devices in the computer system of claim 1 further comprising:

defining the multiple separate 3D zones relative to a frame of reference that is the head of the listener at an origin; and

dividing the multiple separate 3D zones that exist in the 3D space around the head of the listener to include a left zone with an azimuth angle (θ) that is between $\theta = 315^\circ$ to 345° and an elevation angle (φ) that is between $\varphi = 340^\circ$ to 45° , and a right zone with an azimuth angle (θ) that is between $\theta = 15^\circ$ to 45° and an elevation angle (φ) that is between $\varphi = 340^\circ$ to 45° .

3. The method executed by the one or more electronic devices in the computer system of claim 1 further comprising:

providing the 3D zone of the multiple separate 3D zones that exist in the 3D space with a first SLP that is designated as a location to play voices in telephone calls from a telephony application to the listener and not to play music; and

providing another 3D zone of the multiple separate 3D zones that exist in the 3D space with a second SLP that is designated as a location to play the music from a media player application to the listener and not to play the voices in the telephone calls.

4. The method executed by the one or more electronic devices in the computer system of claim 1 further comprising:

assigning the one of the software applications to the 3D zone;

storing an assignment of the one of the software applications to the 3D zone; and

retrieving, when the one of the software applications provides the sound to the listener, the assignment in order to determine to which one of the multiple separate 3D zones to externally localize the sound in the 3D space around the head of the listener according to the assignment.

5. The method executed by the one or more electronic devices in the computer system of claim 1 further comprising:

receiving, from the one of the software applications, an identification of which of the multiple separate 3D zones to provide the sound to externally

localize in the empty space away from the listener, wherein the identification includes an azimuth coordinate and an elevation coordinate of the SLP that is in the empty space away from the head of the listener and located inside the 3D zone.

6. The method executed by the one or more electronic devices in the computer system of claim 1 further comprising:

dividing, with the head of the user being at an origin, the multiple separate 3D zones that exist in the 3D space around the head of the listener into a left zone with a starting azimuth angle (θ) and a stopping θ having values somewhere in a range of $300^\circ \leq \theta \leq 0^\circ$ and a starting elevation angle (φ) and a stopping φ having values somewhere in a range of $340^\circ \leq \varphi \leq 45^\circ$, and a right zone with a starting θ and a stopping θ having values somewhere in a range of $0^\circ \leq \theta \leq 60^\circ$ and starting φ and a stopping φ having values somewhere in a range of $340^\circ \leq \varphi \leq 45^\circ$.

7. The method executed by the one or more electronic devices in the computer system of claim 1 further comprising:

storing user preferences of the listener that include preferences as to which 3D zone that sound from the software applications is preferred to externally localize to the listener; and

consulting the user preferences to determine into which 3D zone to localize the sound from the software applications to the listener.

8. A non-transitory computer-readable storage medium that stores instructions that are executed by one or more processors in a computer system that selects where sound externally localizes to a listener, the one or more processors in the computer system executing the instructions to execute a method comprising:

dividing three-dimensional (3D) space around the listener into multiple zones that have different spherical coordinates;

designating a software application that provides sound to a zone of the multiple zones so that the sound from the software application externally localizes to the listener into the zone designated for the software application;

receiving, from the software application, the sound to externally localize to the listener;

selecting the zone designated for the software application as the zone into which to externally localize the sound to the listener;

convolving, with a digital signal processor (DSP), the sound with head related transfer functions (HRTFs) so the sound externally localizes to the listener as binaural sound in the zone; and

providing, through electronic earphones, the binaural sound to the listener so the binaural sound externally localizes to the listener in the zone at a sound localization point (SLP) that is in empty space away from a head of the listener.

9. The non-transitory computer-readable storage medium of claim 8 that stores instructions that are executed by the one or more processors in the computer system to further execute the method comprising:

dividing the 3D space around the listener into the multiple different zones that include a left zone with a distance (r) from the listener of $r \geq 1.0$ meter and with an azimuth angle (θ) that extends for at least 20° and that has a starting coordinate and a stopping coordinate somewhere between $300^\circ \leq \theta \leq 0^\circ$, and a right zone with the distance (r) from the listener of $r \geq 1.0$ meter and with θ that extends for at least 20° and that has a starting coordinate and a stopping coordinate somewhere between $0^\circ \leq \theta \leq 60^\circ$.

10. The non-transitory computer-readable storage medium of claim 8 that stores instructions that are executed by the one or more processors in the computer system to further execute the method comprising:

dividing the 3D space around the listener into the multiple different zones that include a top zone above a head of the listener with an azimuth angle (θ) that has a starting coordinate and a stopping coordinate somewhere between

$315^\circ \leq \theta \leq 45^\circ$, with an elevation angle (ϕ) that has a starting coordinate and a stopping coordinate somewhere between $45^\circ \leq \phi \leq 135^\circ$, and with a distance (r) from the listener of $r \leq 1.5$ meters.

11. The non-transitory computer-readable storage medium of claim 8 that stores instructions that are executed by the one or more processors in the computer system to further execute the method comprising:

dividing the 3D space around the listener into the multiple different zones that include three different zones that each include unique spherical coordinates;

assigning voices in telephone calls to localize in a first one of the three different zones;

assigning music to localize in a second one of the three different zones;

and

assigning a voice of an intelligent personal assistant to localize in a third one of the three different zones.

12. The non-transitory computer-readable storage medium of claim 8 that stores instructions that are executed by the one or more processors in the computer system to further execute the method comprising:

dividing the 3D space around the listener into the multiple zones that include zones shaped as a rectangular frustum.

13. The non-transitory computer-readable storage medium of claim 8 that stores instructions that are executed by the one or more processors in the computer system to further execute the method comprising:

designating one of the multiple zones as an alert zone where sounds that are warnings or alerts externally localize to the listener; and

providing the sound to externally localize in the alert zone when the sound is a warning or an alert to the listener.

14. The non-transitory computer-readable storage medium of claim 8 that stores instructions that are executed by the one or more processors in the computer system to further execute the method comprising:

receiving, from the software application, the sound to externally localize and information about the sound that includes a zone designation, wherein the zone designation includes coordinates of the SLP included in the zone so the computer system determines where to externally localize the sound to the listener.

15. A method executed by a computer system that selects a location where sound will externally localize to a listener and convolves the sound so the sound externally localizes to the listener, the method comprising:

dividing a three-dimensional (3D) area around the listener into multiple discrete 3D zones from which sounds externally localize to the listener;

assigning different software applications to each of the multiple discrete 3D zones;

receiving, from a software application, the sound to provide to the listener;

determining which one of the multiple discrete 3D zones is a zone that is assigned for the software application;

convolving, with a digital signal processor (DSP), the sound from the software application to generate binaural sound that localizes to the listener at a sound localization point (SLP) included in the zone; and

providing, through earphones, the binaural sound that localizes to the listener at the SLP that is located inside the zone and at empty space away from the listener at a location of at least three feet away from a head of the listener.

16. The method executed by the computer system of claim 15 further comprising:

assigning software applications that play music to a first zone of the multiple discrete 3D zones;

assigning software applications that execute telephone calls to a second zone of the multiple discrete 3D zones; and

assigning software applications that provide speech output of a voice-responsive intelligent personal assistant (IPA) to a third zone of the multiple discrete 3D zones.

17. The method executed by the computer system of claim 15 further comprising:

consulting multiple intelligent user agents (IUAs) of other listeners for a recommendation as to which one of the multiple discrete 3D zones to assign the sound of the software application; and

receiving, from at least one of the IUAs, the recommendation to assign the sound of the software application to the zone.

18. The method executed by the computer system of claim 15 further comprising:

receiving, from the software application, an identification of which one of the multiple discrete 3D zones that the software application is assigned to externally localize the sound to the listener; and

assigning the sound to externally localize to the listener from the zone identified by the software application.

19. The method executed by the computer system of claim 15 further comprising:

consulting a lookup table that stores designations as to which zone each of the different software applications is assigned; and

determining, from the lookup table, that the software application is assigned to the zone selected for the binaural sound to localize to the listener.

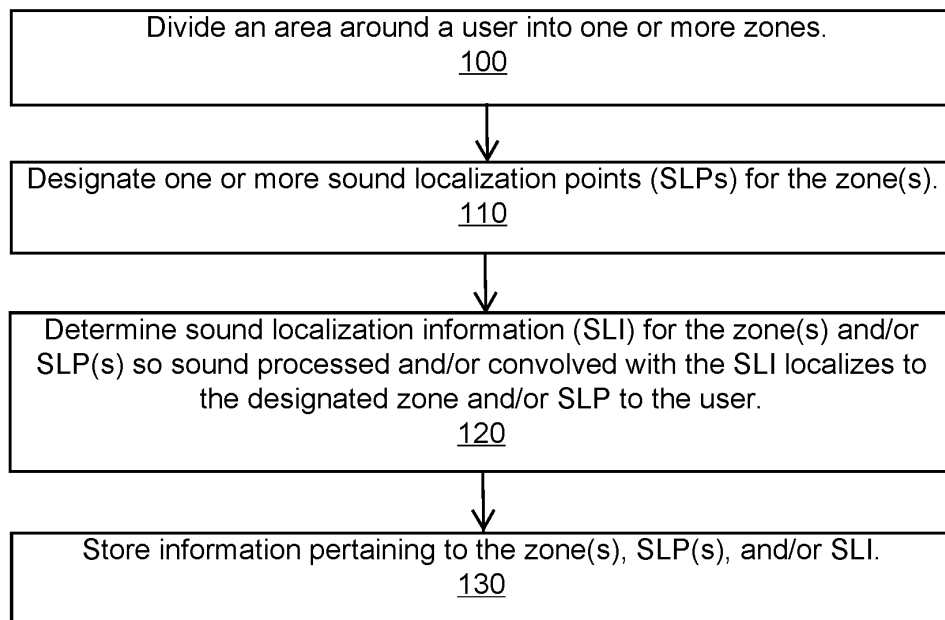
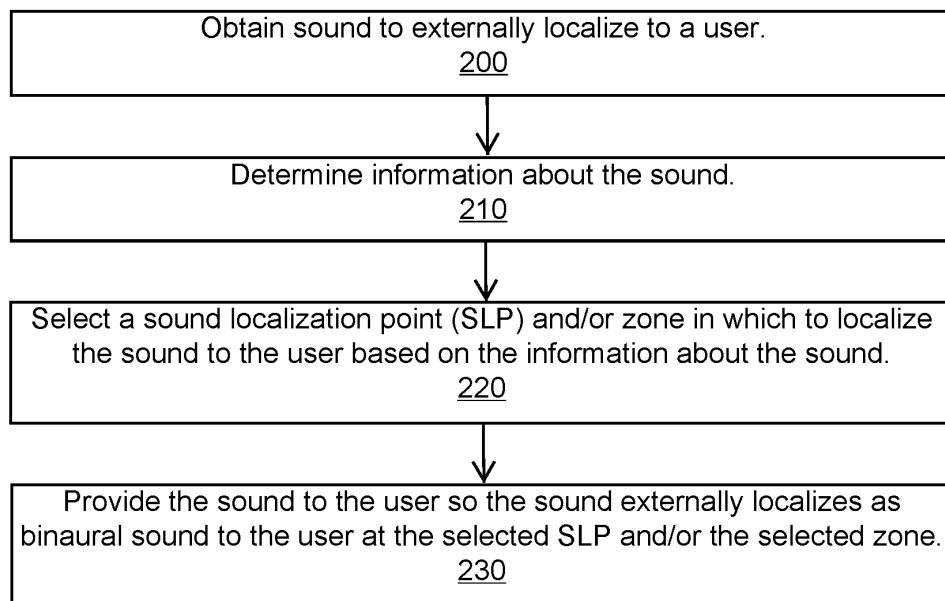
20. The method executed by the computer system of claim 15 further comprising:

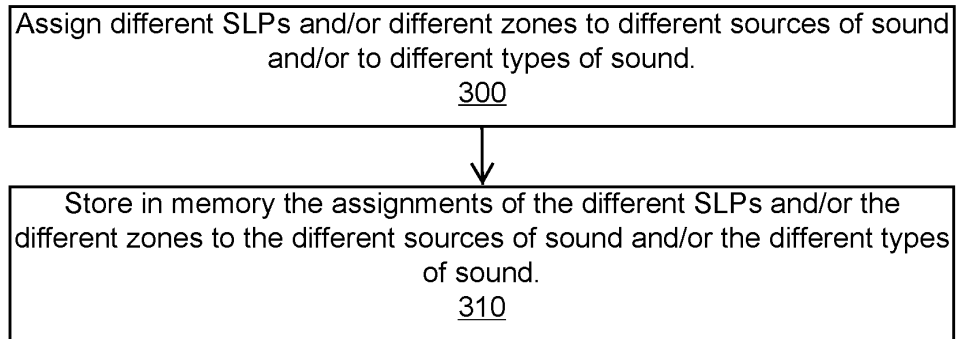
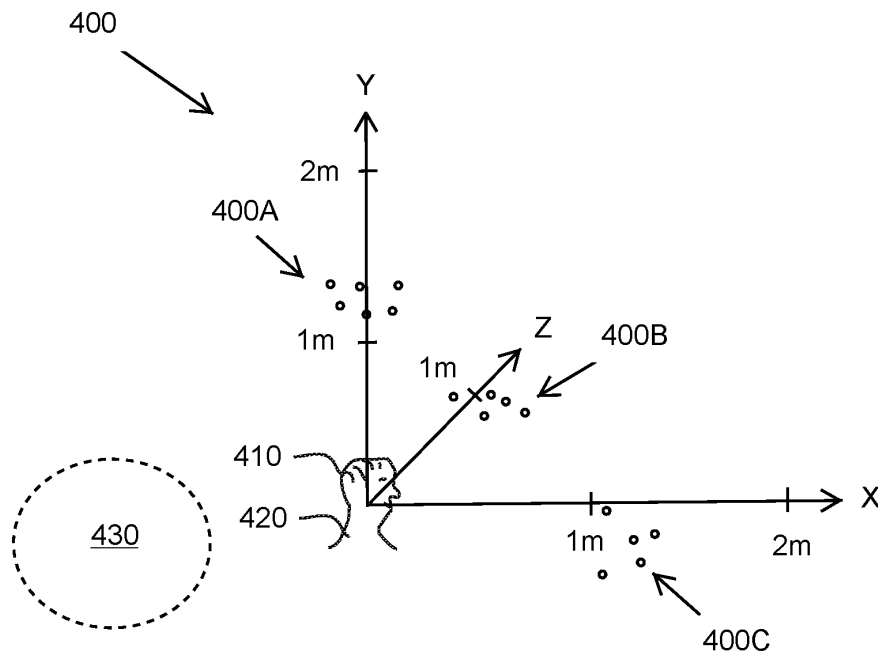
evaluating SLPs where other listeners previously externally localized sounds from the software application; and

selecting the zone to assign the software application for external sound localization based on whether the other listeners selected the zone as an SLP to localize the sounds from the software application.

ABSTRACT

A method selects a location where to localize binaural sound to a listener. Sounds are assigned to different zones or different sound localization points (SLPs). The sounds are convolved with sound localization information so the sounds externally localize as binaural sound away from the listener and into the assigned zone or to the assigned SLP.

**Figure 1****Figure 2**

**Figure 3****Figure 4**

500A



Sound Source	Sound Type	ID	SLP and/or Zone	Transfer Function or Impulse Response	Date	Duration
Telephone Call	Speech	Bob (human)	SLP2	HRIR	01/01/16	53 sec
Internet	Speech and Music	Ad	SLP64	Internal (Mono)	01/01/16	30 sec
Smartphone Program	Speech	Hal (IPA)	SLP1	HRTF	01/01/16	38 sec
Cloud Memory (Movies Folder)	Speech, Music, Sound Effects	E.T.	SLP50-SLP58	HRTFs	01/02/16	2 hours 4 min
Satellite Radio	Speech	Howard Stern	SLP16-SLP20	HRTFs	01/02/16	22 min

Figure 5A

500B



Sound Source	Sound Type	SLP and/or Zone
Tel: +852 6343 0155	Speech and Non-Speech	SLP1: (1.0 m, 10°, 10°)
VR Game (Battle for Mars)	Speech and Music	Speech: Zone 17 Music: SLP3 – SLP5
Charlie (telephone call)	Speech and Non-Speech	SLP6: Internal
Teleconference (Multi-Party)	Speech and Non-Speech	Speaker1: SLP20 Speaker2: SLP21 Speaker3: SLP22 Speaker4: SLP23
Media Player	All	Zones 7 - 9

Figure 5B

500C

Sound Source (Miscellaneous)	Sound Type	SLP and/or Zone
BBC Archives	Speech and Non-Speech	Speech: SLP30 - SLP35 Music: SLP40 Other: Internal
YouTube	Music Videos	Zones 6 - 19
Advertisements	Speech and Non-Speech	Zone 22: Internal (Block external localization)
Appliances	Speech and Non-Speech	Speech: SLP50 Non-Speech: SLP51 (warnings/alerts) Non-Speech: Internal (Other)
Intelligent Personal Assistant (Hal)	Speech	SLP60
Stones.mp3	Music	SLP99
Website (Apple.com)	All	Zone91

Figure 5C

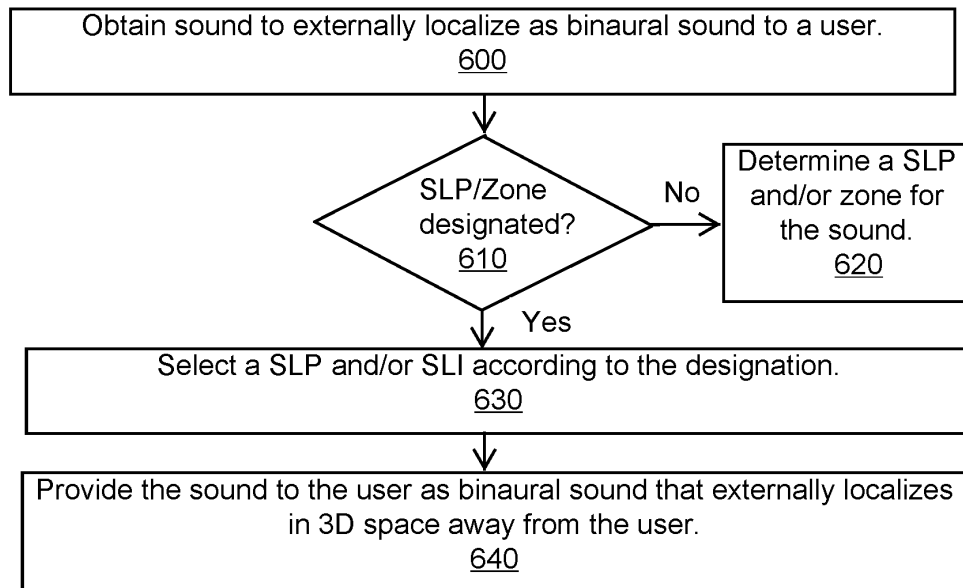
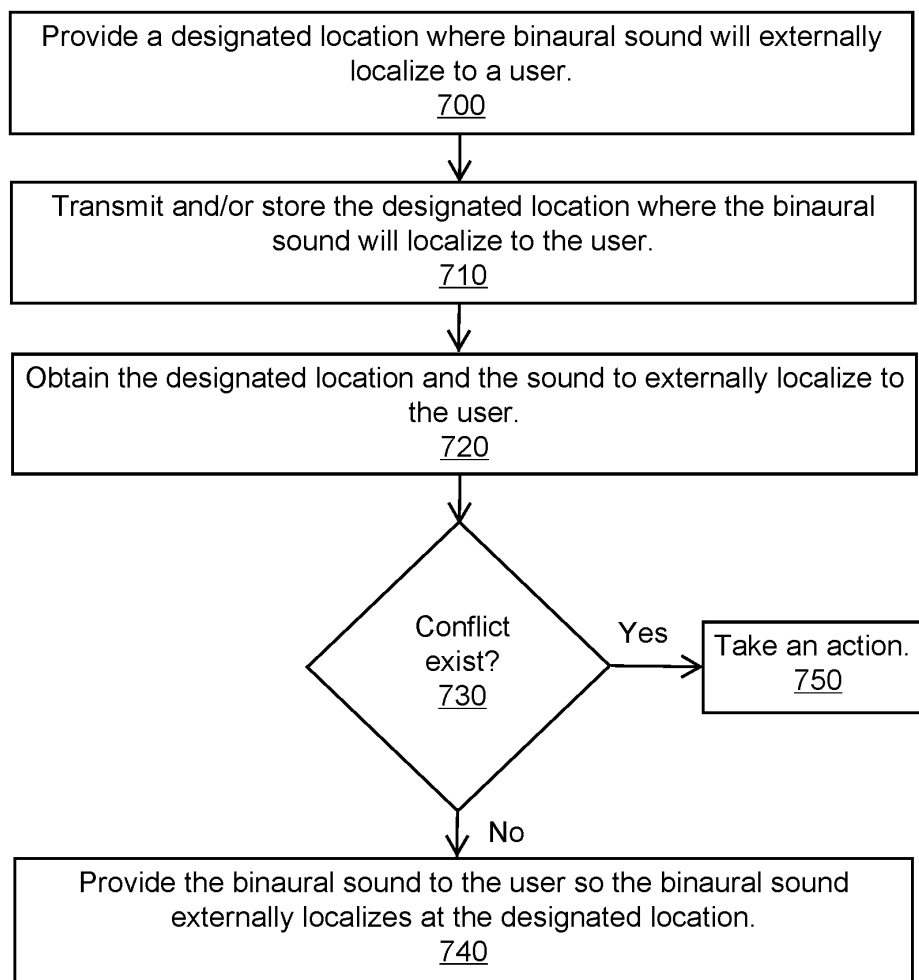
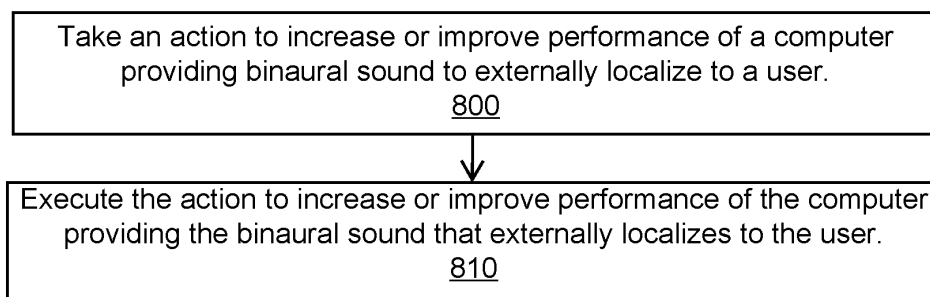
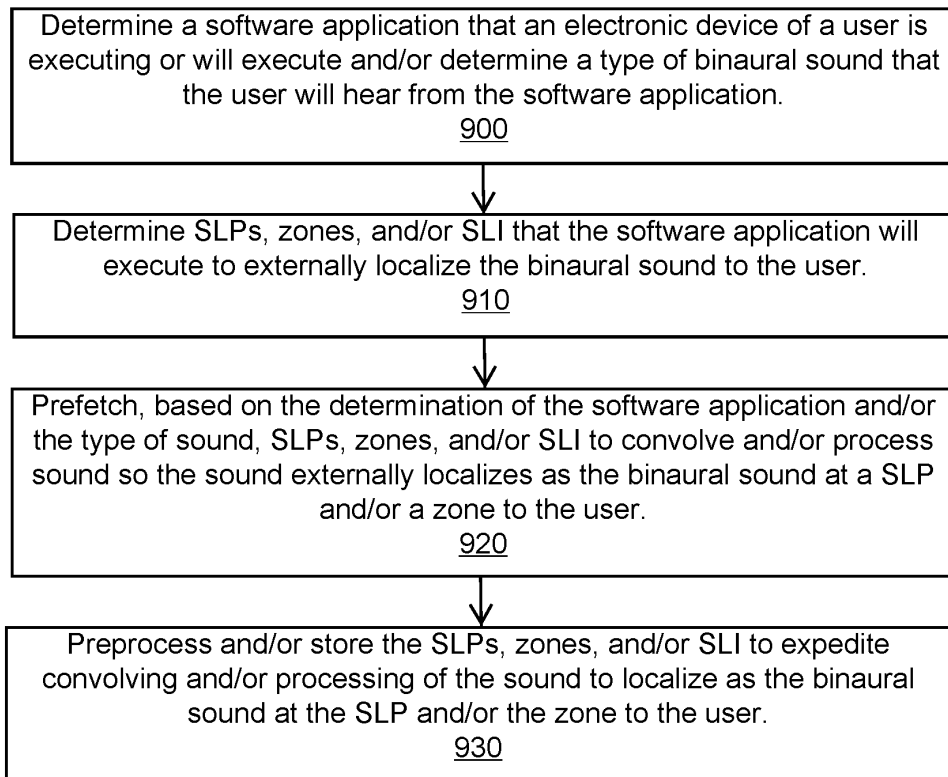
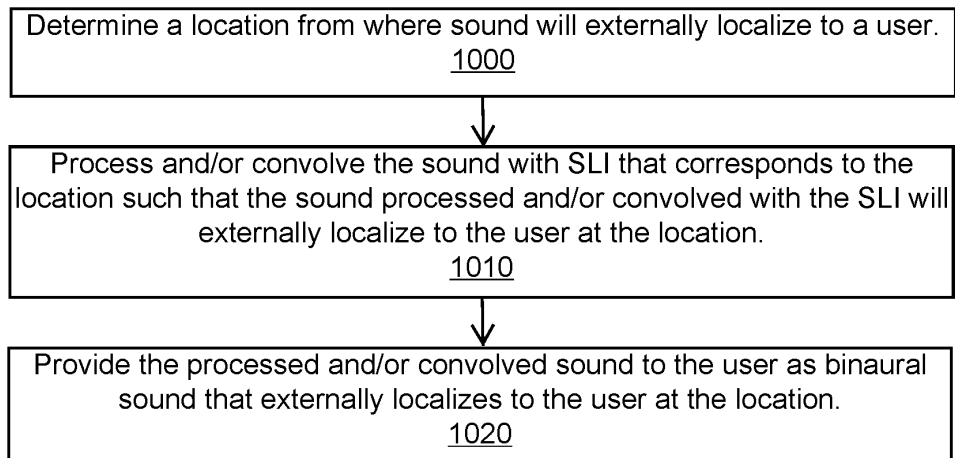


Figure 6

**Figure 7****Figure 8**

**Figure 9****Figure 10**

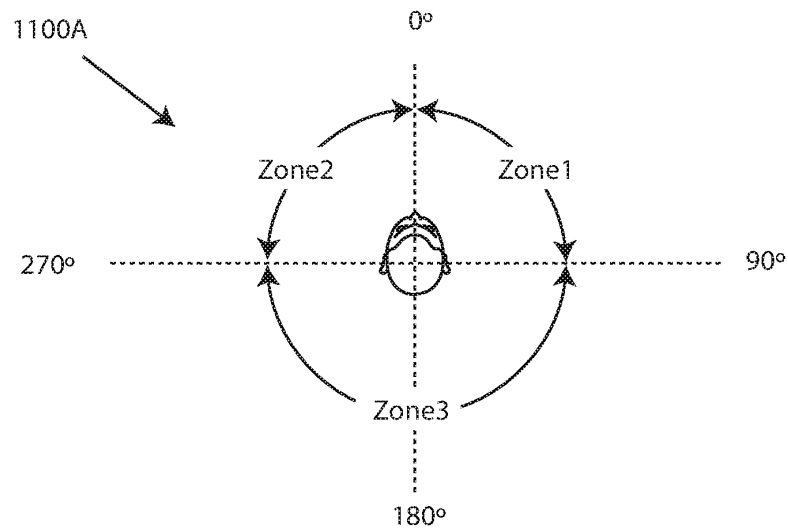


Figure 11A

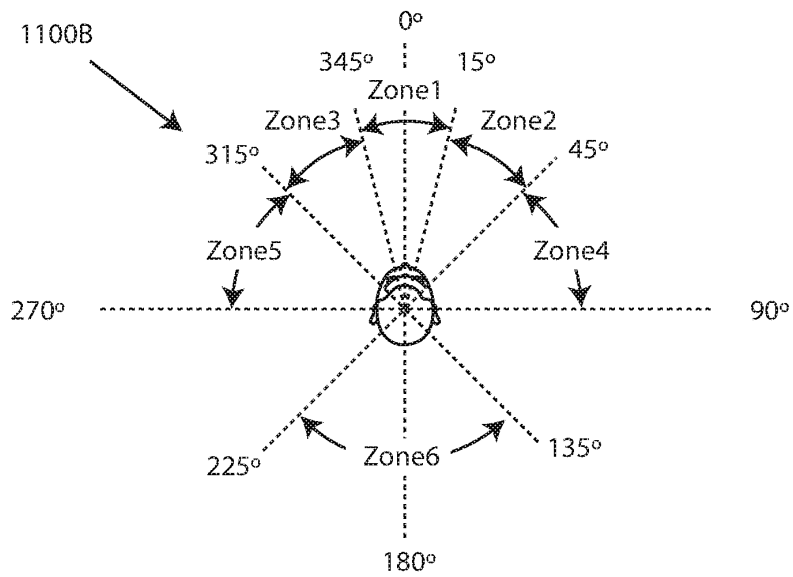


Figure 11B

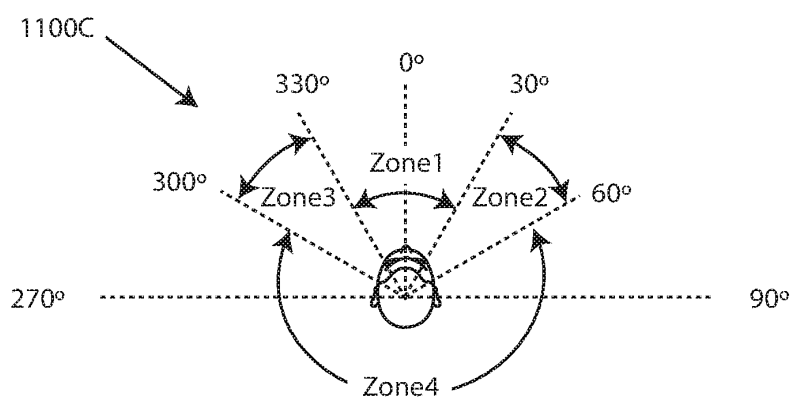


Figure 11C

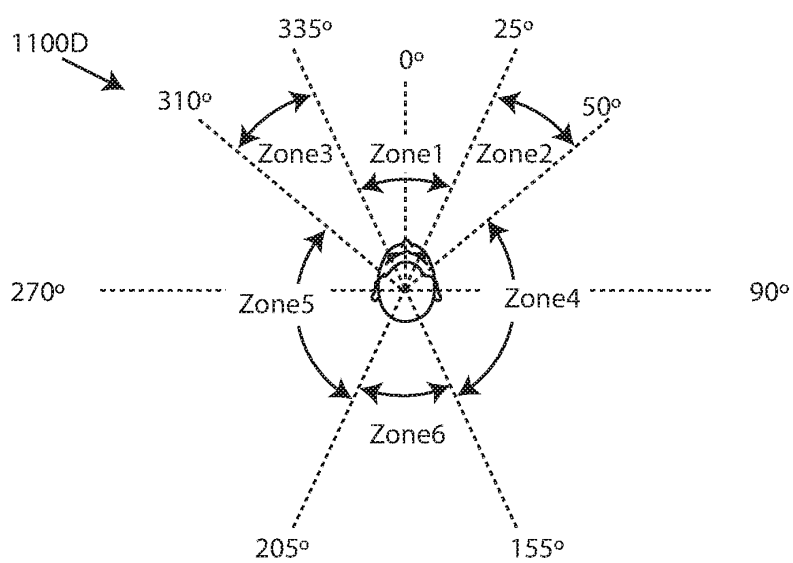


Figure 11D

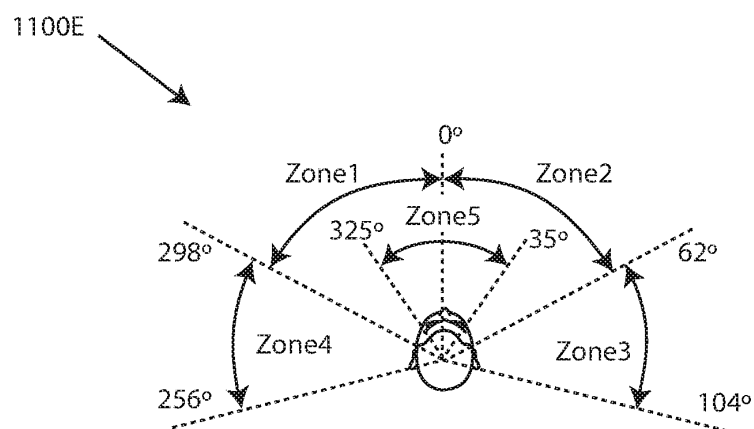


Figure 11E

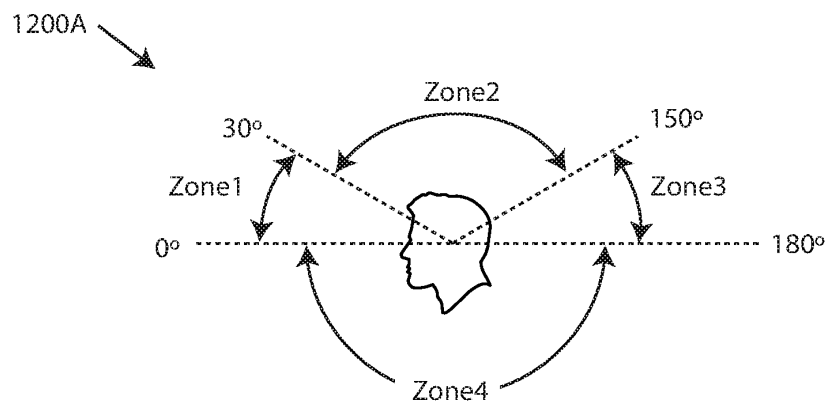


Figure 12A

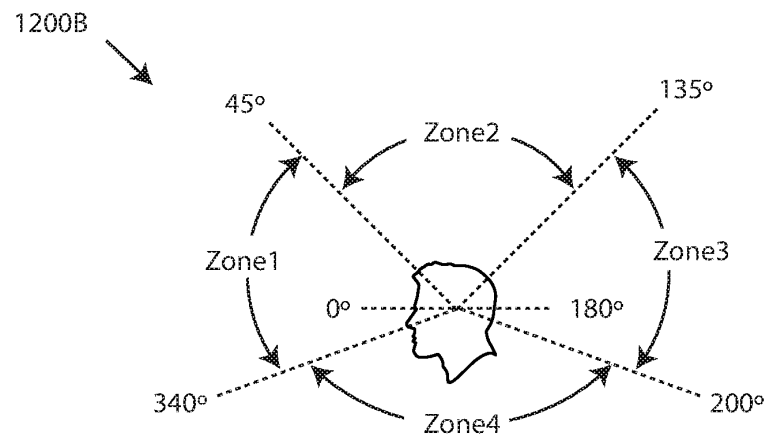


Figure 12B

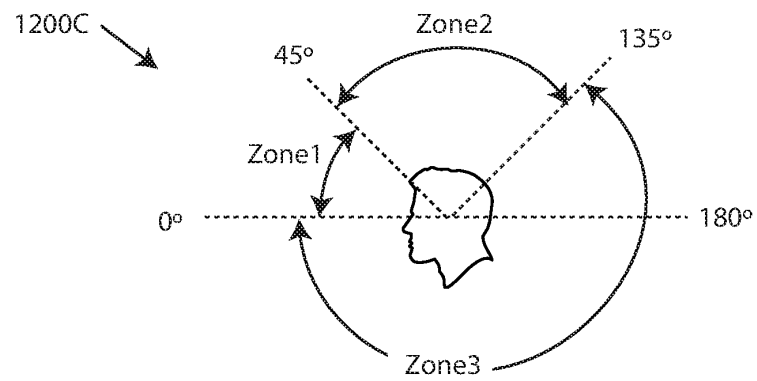


Figure 12C

11/18

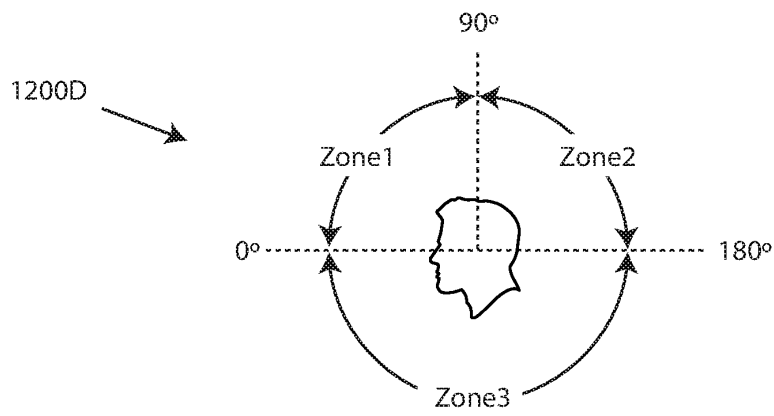


Figure 12D

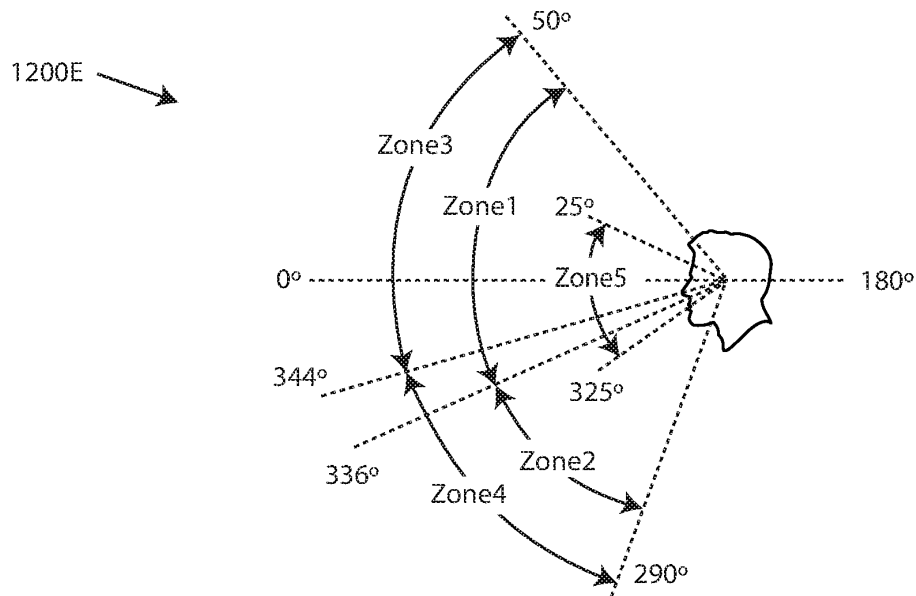


Figure 12E

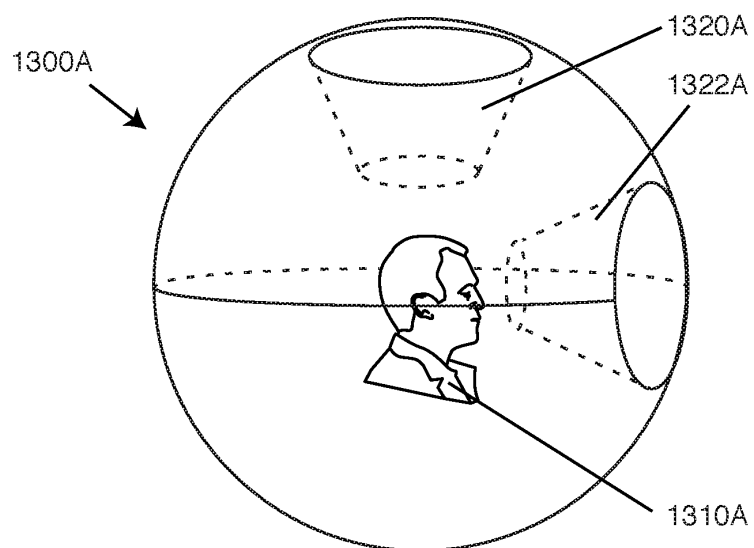


Figure 13A

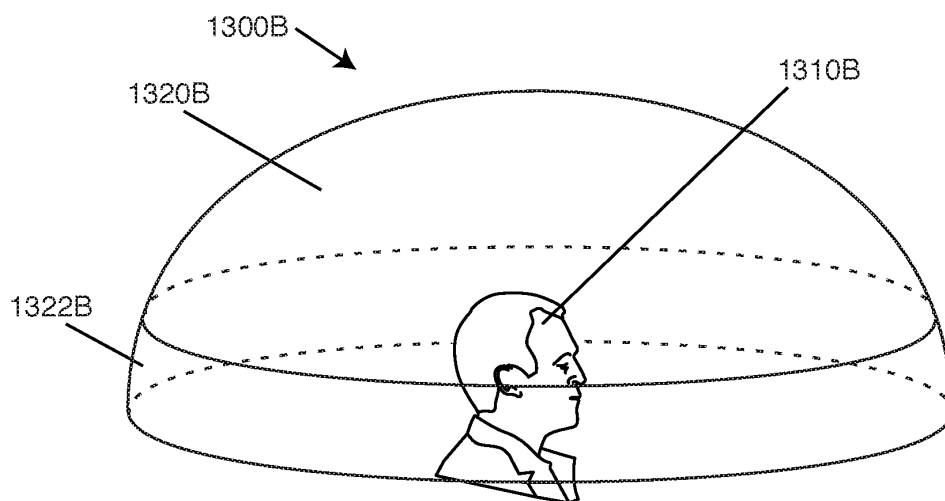


Figure 13B

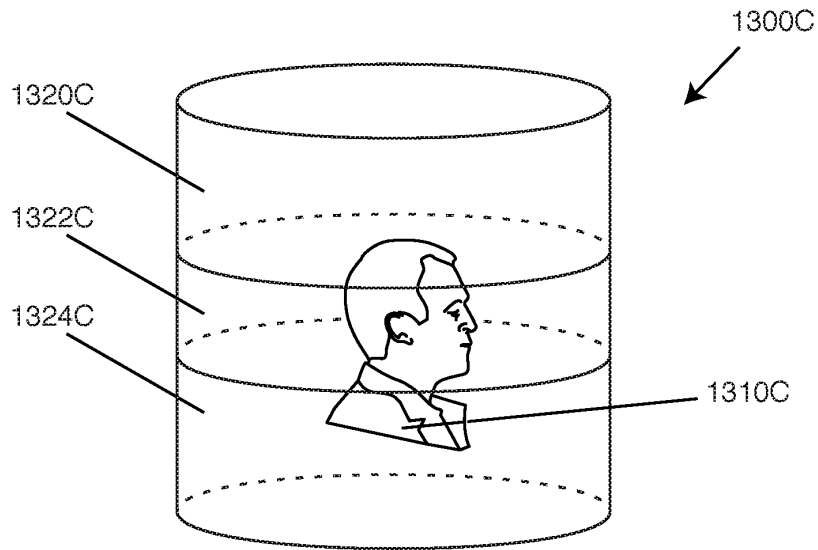


Figure 13C

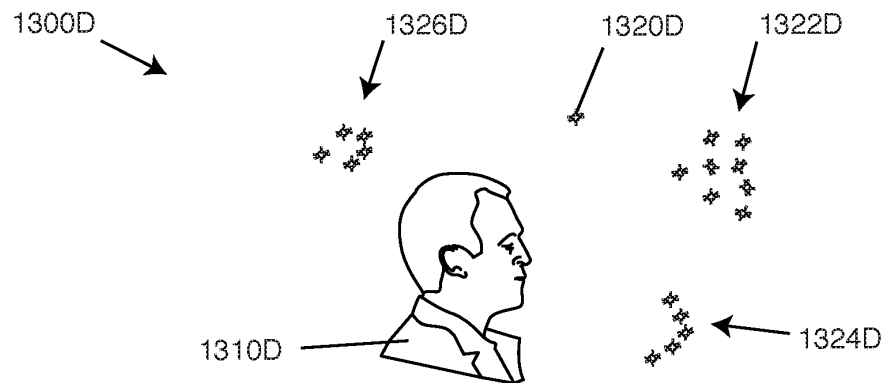


Figure 13D

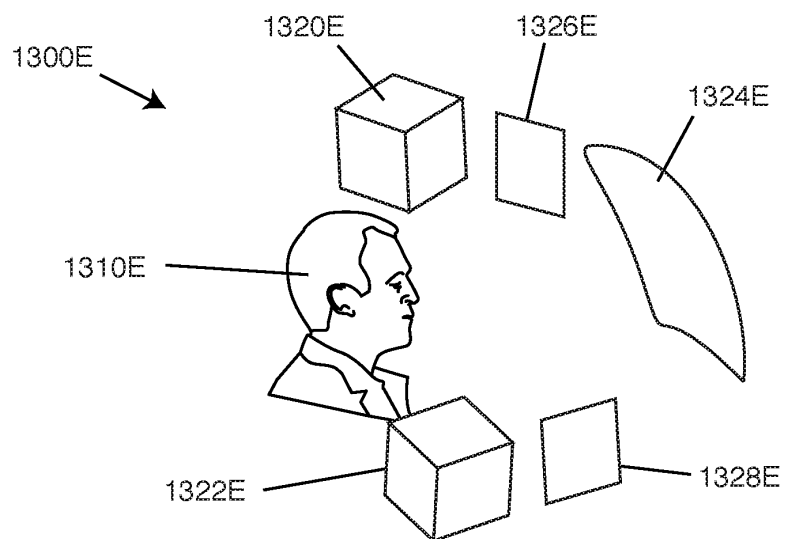


Figure 13E

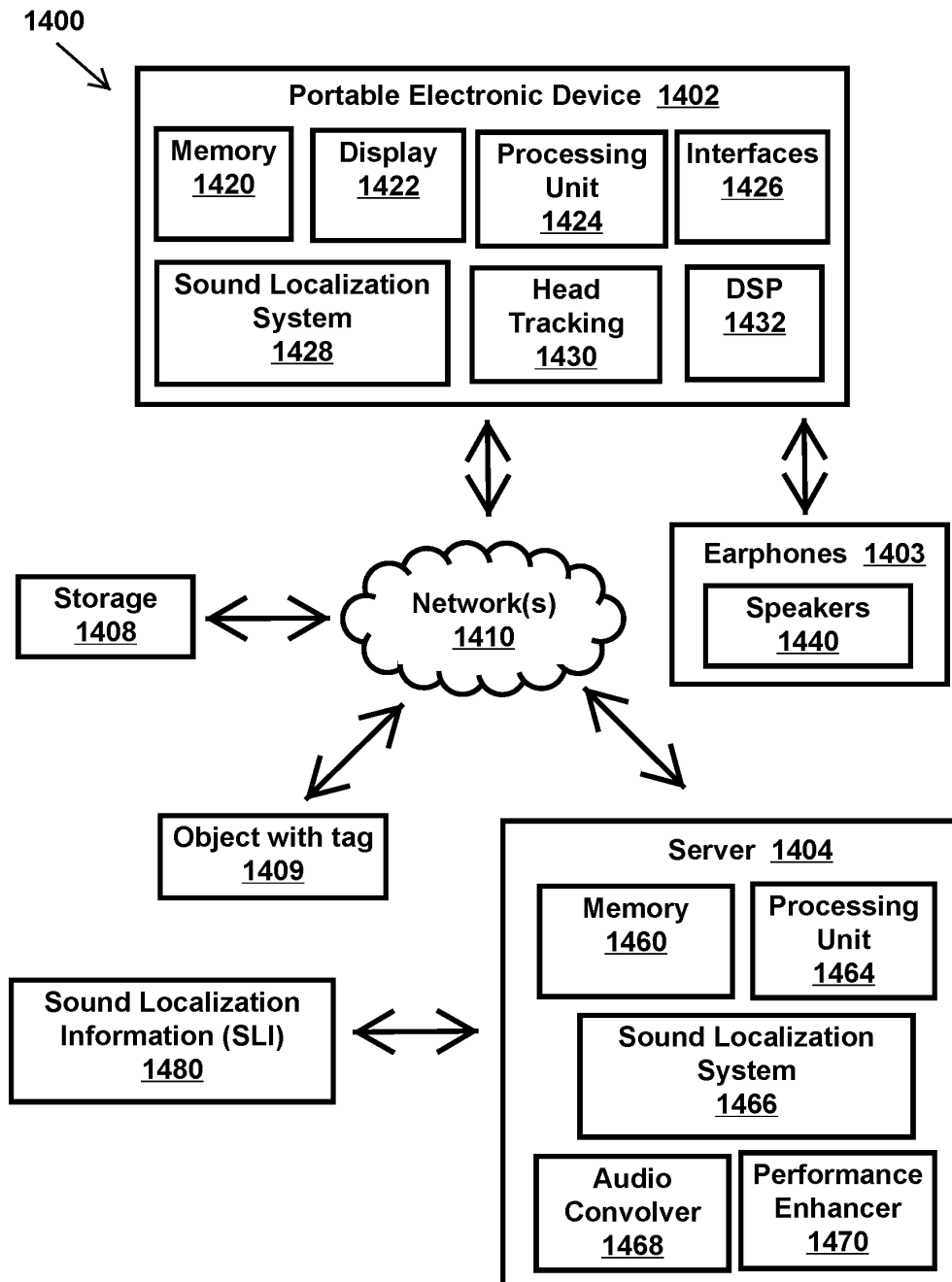


Figure 14

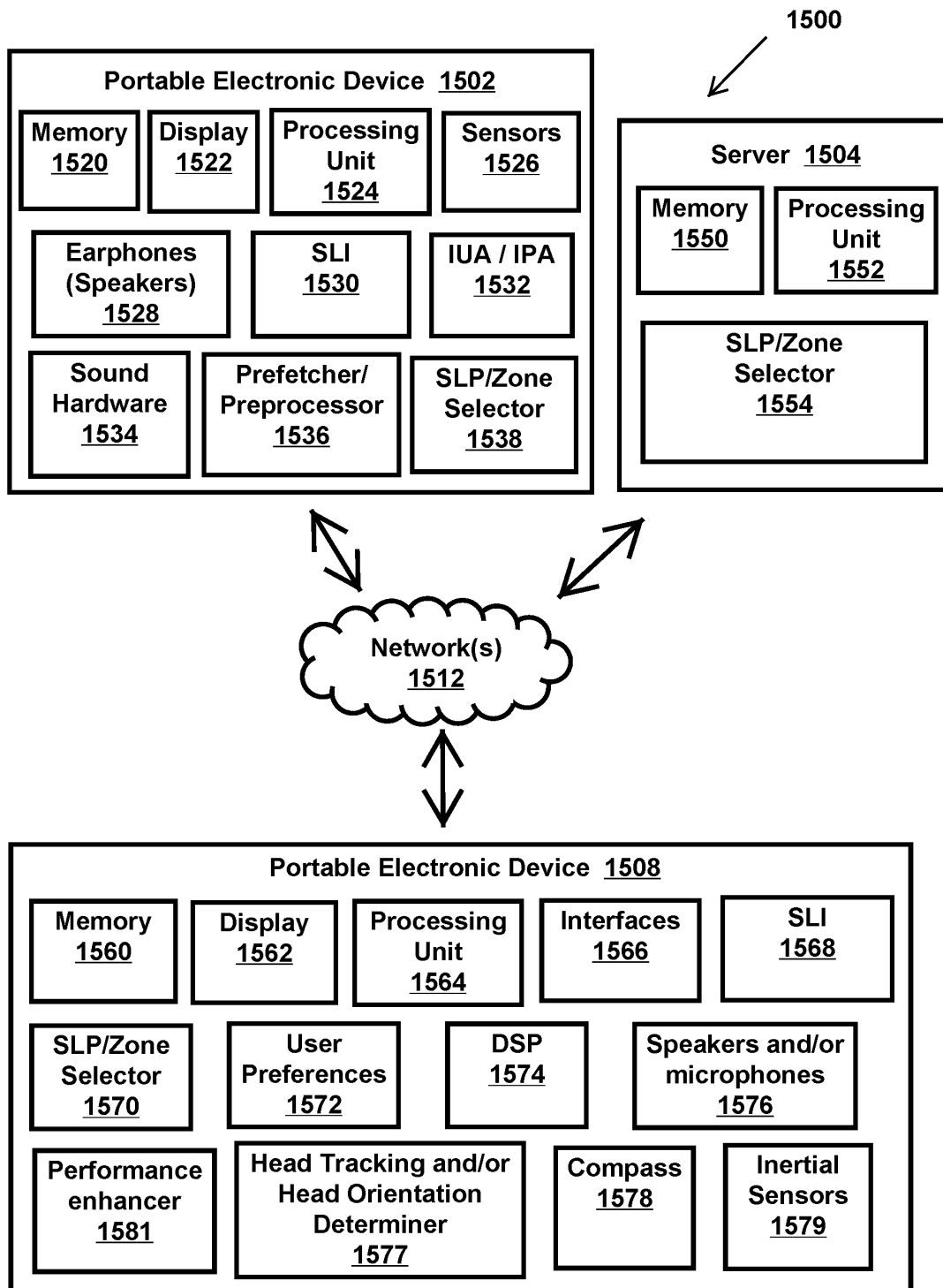


Figure 15

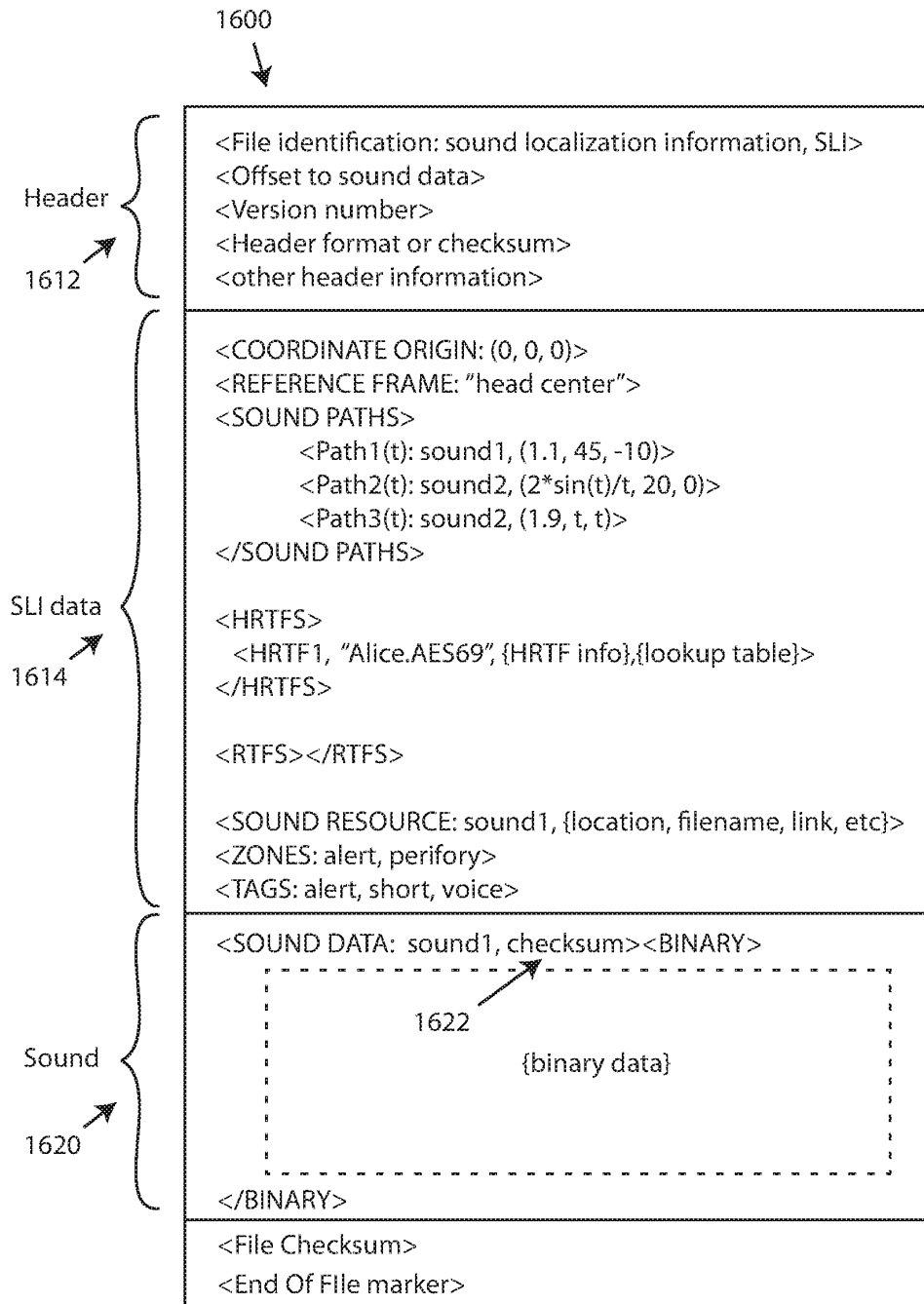


Figure 16

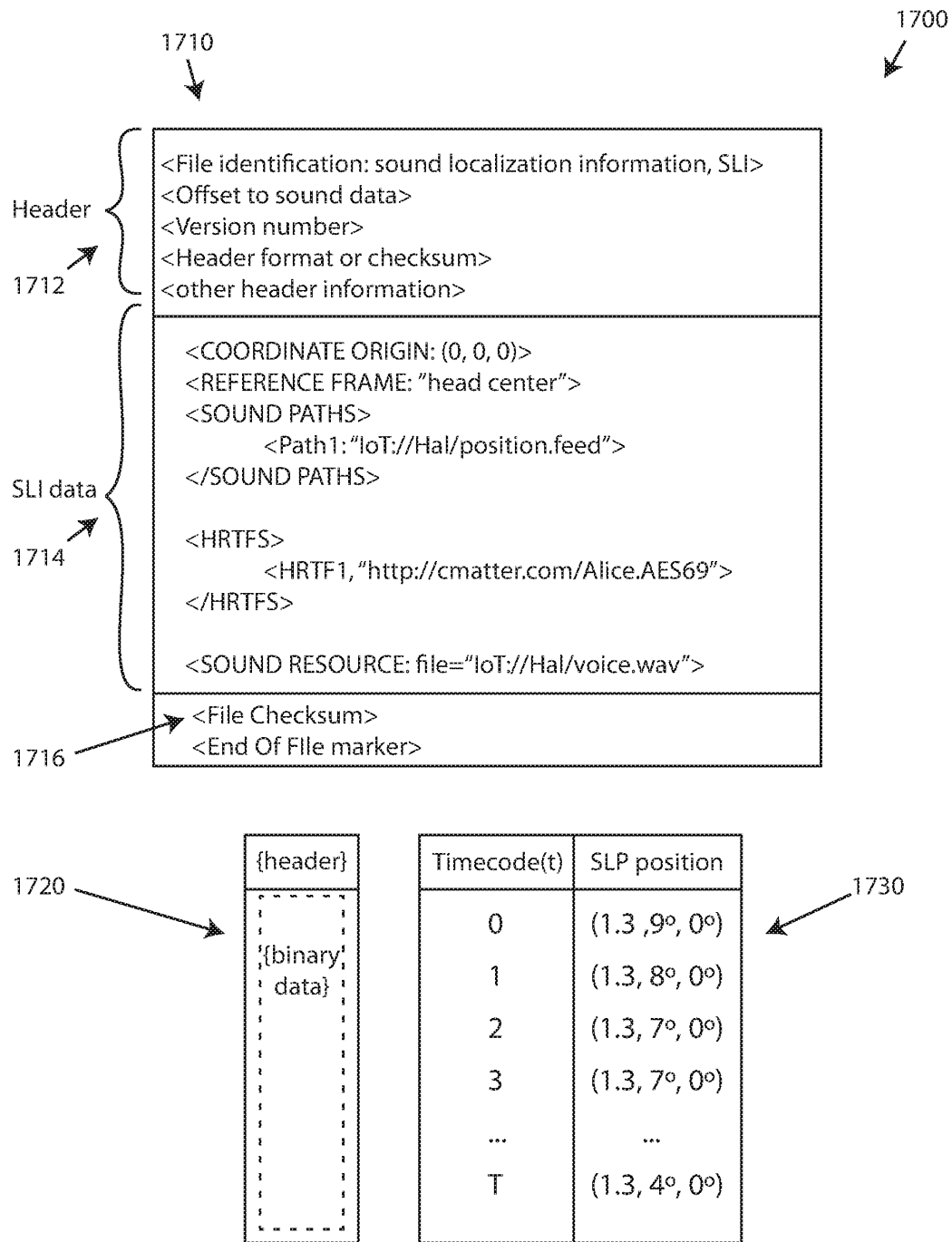


Figure 17

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		Selecting a Location to Localize Binaural Sound		
First Named Inventor/Applicant Name:		Philip S Lyren		
Filer:		Philip Scott Lyren		
Attorney Docket Number:		PSL-037 (CON 4)		
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:				
UTILITY APPL SIZE FEE PER 50 SHEETS >100	2081	1	200	200
Claims:				
Miscellaneous-Filing:				
Petition:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				985

Electronic Acknowledgement Receipt	
EFS ID:	37040094
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	Selecting a Location to Localize Binaural Sound
First Named Inventor/Applicant Name:	Philip S Lyren
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	31-AUG-2019
Filing Date:	
Time Stamp:	20:41:56
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$985
RAM confirmation Number	E20198UK44526357
Deposit Account	
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:	

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Transmittal of New Application	transmittal.pdf	117968	no	1
			c5aeb6c051ee24374c5ed2e7567325653b41c684		
Warnings:					
Information:					
2	Application Data Sheet	Application_Data_Sheet.pdf	1819251	no	7
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Warnings:					
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3	Oath or Declaration filed	Declaration.pdf	2097357	no	3
			12971311b88fbc194d76e01d33ade18299eaf78e		
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4	Specification	Specification.pdf	825351	no	122
			5110c8e201b6d231bbdd9ebc387e6a674270b577		
Warnings:					
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5	Claims	Claims.pdf	185406	no	7
			d8f966565a5d6a8fa436d77d38c7db92611142ae		
Warnings:					
Information:					
6	Abstract	Abstract.pdf	26553	no	1
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Warnings:					
Information:					

7	Oath or Declaration filed	Drawings.pdf	468592	no	18
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Warnings:					
Information:					
8	Fee Worksheet (SB06)	fee-info.pdf	36854	no	2
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Warnings:					
Information:					
Total Files Size (in bytes):				5577332	
<p>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.</p> <p><u>New Applications Under 35 U.S.C. 111</u> 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.</p> <p><u>National Stage of an International Application under 35 U.S.C. 371</u> 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.</p> <p><u>New International Application Filed with the USPTO as a Receiving Office</u> 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.</p>					

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16558088		
Filing Date	31 August 2019		
First Named Inventor	Philip Scott Lyren		
Title	Selecting a Location to Localize Binaural Sound		
Art Unit			
Examiner Name			
Attorney Docket Number	PSL-037 (CON 5)		
SIGNATURE of Applicant or Patent Practitioner			
Signature	/Philip Lyren, #40,709/	Date (Optional)	31 August 2019
Name	Philip Lyren	Registration Number	40,709
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.			
☒ *Total of <u>two</u> forms are submitted.			

This collection of information is required by 37 CFR 1.131, 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.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

64021

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name				
Address				
City	State	Zip		
Country				
Telephone	Email			

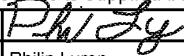
I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

C Matter Limited

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	
Name	Philip Lyren		
Title	Director and General Counsel for C Matter Limited		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ Total of two forms are submitted.

This collection of information is required by 37 CFR 1.131, 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.

POWER OF ATTORNEY BY APPLICANT

No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration Number

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:

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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.
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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.

Electronic Acknowledgement Receipt	
EFS ID:	37040102
Application Number:	16558088
International Application Number:	
Confirmation Number:	1238
Title of Invention:	Selecting a Location to Localize Binaural Sound
First Named Inventor/Applicant Name:	Philip Scott Lyren
Correspondence Address:	PHILIP S. LYREN, PC - 289 Woodland Avenue - Wadsworth OH 44281 US 216-539-0572 Philip_Lyren@Yahoo.com
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-037 (CON 4)
Receipt Date:	31-AUG-2019
Filing Date:	
Time Stamp:	20:48:20
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	Power_Attorney.pdf	216753	no	4
			afd59babf2f76c963af81c76b0f387febad35b92		
Warnings:					
Information:					
Total Files Size (in bytes):			216753		
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