

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)

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

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.
17/062,637	03/29/2022	11290836	PSL-047 (CON3)	2878

64021 7590 03/09/2022
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.

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

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

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

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)

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

Issue Fee Transmittal Form

Application Number	Filing Date	First Named Inventor	Atty. Docket No.	Confirmation No.
17062637	05-Oct-2020	Glen A. Norris	PSL-047 (CON3)	2878

TITLE OF INVENTION :

PROVIDING BINAURAL SOUND BEHIND AN IMAGE BEING DISPLAYED WITH AN ELECTRONIC DEVICE

Entity Status	Application Type	Art Unit	Class - Subclass	EXAMINER
Small	Utility under 35 USC 111(a)	2652	094000	
Issue Fee Due	Publication Due	Total Fee(s) Due	Date Due	Prev. Paid Fee
\$600	\$0	\$600	18-Apr-2022	\$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	02-22-2022
Name	Philip Scott Lyren	Registration Number	40709

WEB IFEE 1.0

Electronic Patent Application Fee Transmittal				
Application Number:		17062637		
Filing Date:		05-Oct-2020		
Title of Invention:		PROVIDING BINAURAL SOUND BEHIND AN IMAGE BEING DISPLAYED WITH AN ELECTRONIC DEVICE		
First Named Inventor/Applicant Name:		Glen A. Norris		
Filer:		Philip Scott Lyren		
Attorney Docket Number:		PSL-047 (CON3)		
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:	45048549
Application Number:	17062637
International Application Number:	
Confirmation Number:	2878
Title of Invention:	PROVIDING BINAURAL SOUND BEHIND AN IMAGE BEING DISPLAYED WITH AN ELECTRONIC DEVICE
First Named Inventor/Applicant Name:	Glen A. Norris
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-047 (CON3)
Receipt Date:	22-FEB-2022
Filing Date:	05-OCT-2020
Time Stamp:	10:42:39
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	E20222LA42362103
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	62308	no	2
			d92ba98ff021c8b3d69098075f94b14a7b6016ec		

Warnings:**Information:**

2	Fee Worksheet (SB06)	fee-info.pdf	40159	no	2
			3a3d6c6b61fdb0393ae2139444115881e544b06d		

Warnings:**Information:**

Total Files Size (in bytes):			102467
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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.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
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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
17/062,637	10/05/2020	2652	830	PSL-047 (CON3)	20	3

CONFIRMATION NO. 2878
CORRECTED FILING RECEIPT



CC000000131261697

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

Date Mailed: 01/21/2022

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)

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

Applicant(s)

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

Power of Attorney:

Philip Lyren--40709

Domestic Priority data as claimed by applicant

This application is a CON of 16/354,182 03/15/2019 PAT 10805758
which is a CON of 16/246,501 01/13/2019 PAT 10791409
which is a CON of 15/603,552 05/24/2017 PAT 10219095

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: No

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: 10/14/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/062,637**

Projected Publication Date: Not Applicable

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

PROVIDING BINAURAL SOUND BEHIND AN IMAGE BEING DISPLAYED WITH AN ELECTRONIC DEVICE

Preliminary Class

700

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 01/18/2022
PHILIP S. LYREN, PC
289 Woodland Avenue
Wadsworth, OH 44281

EXAMINER

SAUNDERS JR, JOSEPH

ART UNIT

PAPER NUMBER

2652

DATE MAILED: 01/18/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/062,637	10/05/2020	Glen A. Norris	PSL-047 (CON3)	2878

TITLE OF INVENTION: User Experience Localizing Binaural Sound During a Telephone Call

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	04/18/2022

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. 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 01/18/2022
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.
17/062,637	10/05/2020	Glen A. Norris	PSL-047 (CON3)	2878

TITLE OF INVENTION: User Experience Localizing Binaural Sound During a Telephone Call

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	04/18/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
SAUNDERS JR, JOSEPH	2652	700-094000

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/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/062,637	10/05/2020	Glen A. Norris	PSL-047 (CON3)	2878
64021	7590	01/18/2022	EXAMINER	
PHILIP S. LYREN, PC			SAUNDERS JR, JOSEPH	
289 Woodland Avenue			ART UNIT	
Wadsworth, OH 44281			PAPER NUMBER	

2652

DATE MAILED: 01/18/2022

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. 17/062,637	Applicant(s) Norris et al.	
	Examiner JOSEPH SAUNDERS	Art Unit 2652	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 the amendment and terminal disclaimer filed December 15, 2021.
☐ 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 21-30,32-38 and 40. 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 _____.	

/JOSEPH SAUNDERS JR/ Primary Examiner, Art Unit 2652	
---	--

<i>Search Notes</i> 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

CPC - Searched*		
Symbol	Date	Examiner
H04S7/303	09/28/2021	/JS/
G06K9/00228	09/28/2021	/JS/
G06K9/00248	09/28/2021	/JS/
G06K9/00288	09/28/2021	/JS/
G06K9/22	09/28/2021	/JS/
H04N5/232	09/28/2021	/JS/
H04N5/23219	09/28/2021	/JS/
H04N7/141	09/28/2021	/JS/
H04N7/147	09/28/2021	/JS/
H04N7/15	09/28/2021	/JS/
H04S7/40	09/28/2021	/JS/
H04N2007/145	09/28/2021	/JS/
H04S2420/00	09/28/2021	/JS/

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.

/JS/ Primary Examiner, Art Unit 2652	
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<i>Search Notes</i> 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

Search Notes		
Search Notes	Date	Examiner
Search Notes: 16/354182	09/28/2021	/JS/
EAST: Text of All Databases	09/28/2021	/JS/
Inventor (No Assignee of Record)	09/29/2021	/JS/
Updated Search/Reconsidered References	01/11/2022	/JS/

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
Same As Above	See EAST Search Notes	01/11/2022	/JS/

/JS/ Primary Examiner, Art Unit 2652	
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Issue Classification 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

CPC						
Symbol					Type	Version
H04S	/	7	/	303	F	2013-01-01
H04N	/	7	/	147	I	2013-01-01
H04N	/	7	/	15	I	2013-01-01
H04S	/	7	/	40	I	2013-01-01
H04N	/	5	/	232	I	2013-01-01
G06V	/	10	/	17	I	2022-01-01
G06V	/	40	/	161	I	2022-01-01
G06V	/	40	/	165	I	2022-01-01
G06V	/	40	/	172	I	2022-01-01
H04N	/	7	/	141	I	2013-01-01
H04N	/	5	/	23219	I	2013-01-01
H04S	/	2420	/	00	A	2013-01-01
H04N	/	2007	/	145	A	2013-01-01

CPC Combination Sets					
Symbol				Type	Set
	/		/		

NONE	Total Claims Allowed:	
(Assistant Examiner)	(Date)	18
/JOSEPH SAUNDERS JR/ Primary Examiner, Art Unit 2652	13 January 2022	O.G. Print Claim(s)
(Primary Examiner)	(Date)	1
		O.G. Print Figure
		5B

U.S. Patent and Trademark Office

Part of Paper No.: 20220113

Issue Classification 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

INTERNATIONAL CLASSIFICATION		
CLAIMED		
G06F	17	00
NON-CLAIMED		
G06F	17	00

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
700	94

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

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	18	
/JOSEPH SAUNDERS JR/ Primary Examiner, Art Unit 2652	13 January 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5B

U.S. Patent and Trademark Office

Part of Paper No.: 20220113

Issue Classification 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

☐ 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	8	28	16	37						
	2		11		20	9	29	17	38						
	3		12	1	21	10	30		39						
	4		13	2	22		31	18	40						
	5		14	3	23	11	32								
	6		15	4	24	12	33								
	7		16	5	25	13	34								
	8		17	6	26	14	35								
	9		18	7	27	15	36								

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	18	
/JOSEPH SAUNDERS JR/ Primary Examiner, Art Unit 2652	13 January 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	5B

U.S. Patent and Trademark Office

Part of Paper No.: 20220113

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	115	(US-20170295278-\$ or US-20100316232-\$ or US-20170366914-\$ or US-20170366913-\$ or US-20170332186-\$ or US-20160183011-\$ or US-20160142848-\$ or US-20160183024-\$ or US-20130041648-\$ or US-20120093320-\$ or US-20090041254-\$ or US-20070110265-\$ or US-20150010160-\$).did. or (US-9584653-\$ or US-9900555-\$ or US-8351589-\$ or US-9961208-\$ or US-9749473-\$ or US-9955279-\$ or US-9584942-\$ or US-9602946-\$ or US-9037468-\$ or US-9530426-\$ or US-6760447-\$ or US-8627213-\$ or US-9368117-\$ or US-9426589-\$).did. or (WO-2007045016-\$).did. (US-20170295278-\$ or US-20090041254-\$ or US-20140079212-\$ or US-20060274901-\$ or US-20030044002-\$ or US-20180091921-\$ or US-20150181355-\$ or US-20150049892-\$ or US-20180027349-\$ or US-20170245088-\$ or US-20130041648-\$ or US-20110153043-\$ or US-20110109798-\$ or US-20090169037-\$ or US-20090122995-\$ or US-20170332186-\$ or US-20180041849-\$ or US-20170094440-\$ or US-20050135643-\$ or US-20180343534-\$).did. or (US-7664272-\$ or US-9510112-\$ or US-9307331-\$ or US-8155358-\$).did. or (GB-2542609-\$).did. (US-20180343534-\$ or US-20190335287-\$ or US-20190250875-\$ or US-20190215636-\$ or US-20180164588-\$ or US-20160239252-\$ or US-20150304790-\$ or US-20160379660-\$ or US-20180046431-\$ or US-20160212272-\$ or US-20180027349-\$ or US-20150245159-\$).did. or (US-10178493-\$ or US-9998847-\$ or US-10051402-\$ or US-10219095-\$ or US-9591427-\$).did. or (US-20180343534-\$).did.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 10:37
S2	19	S1 and line adj2 sight	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2021/09/28 10:38

			JPO; DERWENT; IBM_TDB			
S3	149	(H04S7/303 G06K9/00228 G06K9/00248 G06K9/00288 G06K9/22 H04N5/232 H04N5/23219 H04N7/141 H04N7/147 H04N7/15 H04S7/40 H04N2007/145 H04S2420/00) and (sound near2 localiz\$5) and (line adj2 sight)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 10:51
S4	53	(H04S7/303 G06K9/00228 G06K9/00248 G06K9/00288 G06K9/22 H04N5/232 H04N5/23219 H04N7/141 H04N7/147 H04N7/15 H04S7/40 H04N2007/145 H04S2420/00) and (sound near2 localiz\$5) and (behind near5 (display image device))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 13:06
S5	52	binaural and (sound near2 localiz\$5) same (behind near5 (display image device))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 13:24
S6	15	("20050105442" "20060098830" "20060120533" "20080008326" "20080013746" "20080226084" "20090034772" "20090123007" "20110144783" "20120070021" "20140064517" "20150215721" "4199658" "6442277").PN. OR ("10721577" "2016/0088393" "2018/0007485" "2020/0084562" "9788120").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2021/09/28 13:36
S7	3	(11/574410 12/045668 12/271289).APP.	USPAT; USOCR	OR	ON	2021/09/28 13:43
S8	83	("20030026441" "20030086572" "20050053249" "20050117753" "20050117762" "20060045295" "20060062410" "20060126878" "20060210101" "20060269070" "20060280323" "20070030976" "20070154019" "20070217621" "20070230724" "20070286427" "20080101631" "20080165979" "20080226084" "20080273721" "20090010455" "20090028358" "20100189267" "5109415" "5440639" "5666425" "5761315" "5799094" "5870484" "5999630" "6243476"	US-PGPUB; USPAT; USOCR	OR	ON	2021/09/28 13:43

		"6430294" "7113609" "7130430" "7545946" "7561706" "7577260" "7606380" "7929709" "8041060" "8170245" "8223992").PN. OR ("2008/0226084" "2009/0034772" "2009/0123007" "8005245" "8428268" "8494189").URPN.				
S9	410	((("NORRIS") near3 ("Glen")) OR (("LYREN") near3 ("Philip"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2021/09/29 17:35
S10	41	binaural and (sound near2 localiz\$5) and (behind near5 (display image device)) and (line adj2 sight)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/29 18:38
S11	115	(US-20170295278-\$ or US-20100316232-\$ or US-20170366914-\$ or US- 20170366913-\$ or US-20170332186-\$ or US-20160183011-\$ or US-20160142848-\$ or US-20160183024-\$ or US- 20130041648-\$ or US-20120093320-\$ or US-20090041254-\$ or US-20070110265-\$ or US-20150010160-\$).did. or (US- 9584653-\$ or US-9900555-\$ or US- 8351589-\$ or US-9961208-\$ or US- 9749473-\$ or US-9955279-\$ or US- 9584942-\$ or US-9602946-\$ or US- 9037468-\$ or US-9530426-\$ or US- 6760447-\$ or US-8627213-\$ or US- 9368117-\$ or US-9426589-\$).did. or (WO- 2007045016-\$).did. (US-20170295278-\$ or US-20090041254-\$ or US- 20140079212-\$ or US-20060274901-\$ or US-20030044002-\$ or US-20180091921-\$ or US-20150181355-\$ or US- 20150049892-\$ or US-20180027349-\$ or US-20170245088-\$ or US-20130041648-\$ or US-20110153043-\$ or US- 20110109798-\$ or US-20090169037-\$ or US-20090122995-\$ or US-20170332186-\$ or US-20180041849-\$ or US- 20170094440-\$ or US-20050135643-\$ or US-20180343534-\$).did. or (US-7664272- \$ or US-9510112-\$ or US-9307331-\$ or US-8155358-\$).did. or (GB-2542609- \$).did. (US-20180343534-\$ or US- 20190335287-\$ or US-20190250875-\$ or	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 16:59

		US-20190215636-\$ or US-20180164588-\$ or US-20160239252-\$ or US-20150304790-\$ or US-20160379660-\$ or US-20180046431-\$ or US-20160212272-\$ or US-20180027349-\$ or US-20150245159-\$).did. or (US-10178493-\$ or US-9998847-\$ or US-10051402-\$ or US-10219095-\$ or US-9591427-\$).did. or (US-20180343534-\$).did.				
S12	19	S11 and line adj2 sight	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 16:59
S13	157	(H04S7/303 G06K9/00228 G06K9/00248 G06K9/00288 G06K9/22 H04N5/232 H04N5/23219 H04N7/141 H04N7/147 H04N7/15 H04S7/40 H04N2007/145 H04S2420/00) and (sound near2 localiz\$5) and (line adj2 sight)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:00
S14	56	(H04S7/303 G06K9/00228 G06K9/00248 G06K9/00288 G06K9/22 H04N5/232 H04N5/23219 H04N7/141 H04N7/147 H04N7/15 H04S7/40 H04N2007/145 H04S2420/00) and (sound near2 localiz\$5) and (behind near5 (display image device))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:03
S15	53	binaural and (sound near2 localiz\$5) same (behind near5 (display image device))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:05
S16	15	("20050105442" "20060098830" "20060120533" "20080008326" "20080013746" "20080226084" "20090034772" "20090123007" "20110144783" "20120070021" "20140064517" "20150215721" "4199658" "6442277").PN. OR ("10721577" "2016/0088393" "2018/0007485" "2020/0084562" "9788120").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2022/01/11 17:06
S17	3	(11/574410 12/045668 12/271289).APP.	USPAT; USOCR	OR	ON	2022/01/11 17:08

S18	84	("20030026441" "20030086572" "20050053249" "20050117753" "20050117762" "20060045295" "20060062410" "20060126878" "20060210101" "20060269070" "20060280323" "20070030976" "20070154019" "20070217621" "20070230724" "20070286427" "20080101631" "20080165979" "20080226084" "20080273721" "20090010455" "20090028358" "20100189267" "5109415" "5440639" "5666425" "5761315" "5799094" "5870484" "5999630" "6243476" "6430294" "7113609" "7130430" "7545946" "7561706" "7577260" "7606380" "7929709" "8041060" "8170245" "8223992").PN. OR ("2008/0226084" "2009/0034772" "2009/0123007" "8005245" "8428268" "8494189").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2022/01/11 17:09
S19	415	((("NORRIS") near3 ("Glen")) OR (("LYREN") near3 ("Philip"))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2022/01/11 17:20
S20	41	binaural and (sound near2 localiz\$5) and (behind near5 (display image device)) and (line adj2 sight)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:21
S21	5	sound same line adj of adj sight	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:21
S22	27	sound with line adj2 sight with behind	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:22
S23	79	sound same line adj2 sight with behind	US-PGPUB; USPAT; USOCR; FPRS; EPO;	OR	ON	2022/01/11 17:23

			JPO; DERWENT; IBM_TDB			
S24	252	sound same (line straight) near2 behind	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:24
S25	7	(binaural near2 sound) same ((hand near2 held) handheld) same behind	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:33
S26	266	(binaural near2 sound) same ((hand near2 held) handheld)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:33
S27	374	(binaural near2 sound) and ((hand near2 held) handheld) and ((far adj field) ("near" adj field))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:40
S28	148	(binaural near2 sound) and ((hand near2 held) handheld) and ((far adj field) and ("near" adj field))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2022/01/11 17:41
S29	31	("10117038").PN. OR ("10440489" "2015/0010160").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2022/01/11 17:54

1/13/2022 2:06:42 PM

C:\Users\jsaunders1\Documents\EAST\Workspaces\17_062637_2.wsp

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Glen A. Norris, et al.	Examiner:	Joseph Saunders Jr.
Serial No.:	17/062,637	Group Art Unit:	2652
Filed:	5 October 2020	Docket No.:	PSL-047 (CON3)
Title:	Providing Binaural Sound Behind an Image Being Displayed with an Electronic Device		

RESPONSE TO OFFICE ACTION

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

Condition for Allowance

Applicant files this response to place this application in condition for allowance.

Double Patenting

Applicant filed a terminal disclaimer for USPN 10805758.

Claim Rejections: 35 USC 112

Claims 37-40 are rejected under 35 USC 112, second paragraph, as being indefinite. Applicant corrects a typographical error to cure these rejections.

Claim Rejections: 35 USC 102

Claims 28 and 36 are rejected under 35 USC 102 as being anticipated by US 200500053249 (Wu). Applicant amends independent claim 28 to include recitations of allowed dependent claim 31 and amends independent claim 36 to include recitations of allowed dependent claim 39.

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. (previously presented) A method, comprising:

displaying video on a display of a portable electronic device (PED) held in a hand of a user; and

processing, with one or more processors, sound for the video to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs behind the PED held in the hand of the user and along a line-of-sight from the user to the PED.

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

tracking, with one or more sensors, movement of a head of the user; and

processing, with the one or more processors, the sound for the video such that the SLP for the sound for the video continues to have the coordinate location that occurs behind the PED held in the hand of the user as the head of the user moves.

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

processing, with the one or more processors, the sound for the video with far-field head-related transfer functions (HRTFs) while a location of the PED held

in the hand of the user is less than one meter from the user and within a near-field distance.

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

processing, with the one or more processors, the sound for the video with head-related transfer functions (HRTFs) having a coordinate location that matches the coordinate location of the SLP that occurs behind the PED held in the hand of the user and along the line-of-sight from the user to the PED.

25. (previously presented) The method of claim 21, wherein the one or more processors include a digital signal processor (DSP) that processes the sound for the video with far-field head-related transfer functions (HRTFs) while the PED is located at a near-field distance from a face of the user, and the PED is one of a smartphone and a tablet computer.

26. (previously presented) The method of claim 21, wherein the coordinate location of the SLP is located a distance (d_1) from a head of the user in which $d_1 > 1.0$ meter, and the PED is located a distance (d_2) from the head of the user in which $d_2 < 1.0$ meter.

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

sensing, with one or more sensors in the PED, when the PED rotates in the hand of the user; and

automatically switching, in response to the one or more sensors in the PED sensing rotation of the PED in the hand of the user, the binaural sound to stereo sound.

28. (currently amended) An electronic device, comprising:

a display that displays an image that occurs within a near-field distance from a head of a user; and

one or more processors that process sound for the image to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance, wherein the one or more processors include a digital signal processor (DSP) that processes the sound for the image with far-field head-related transfer functions (HRTFs) while the electronic device is located at the near-field distance from the head of the user.

29. (previously presented) The electronic device of claim 28, wherein the image is an augmented reality (AR) image, and the display is included with electronic glasses worn on the head of the user.

30. (previously presented) The electronic device of claim 28, wherein the image is a virtual reality (VR) image, and the display is included with a head mounted display worn on the head of the user.

31. (canceled)

32. (previously presented) The electronic device of claim 28 further comprising:

one or more sensors that detect rotation of the electronic device, wherein the binaural sound automatically switches to stereo sound in response to the one or more sensors detecting the rotation of the electronic device.

33. (previously presented) The electronic device of claim 28, wherein the binaural sound automatically switches to stereo sound in response to the electronic device detecting a change to a head orientation of the user that exceeds a threshold value in an azimuth direction.

34. (previously presented) The electronic device of claim 28, wherein the image is an augmented reality (AR) image of an intelligent user assistant (IUA) that is located less than one meter away from the head of the user, and a voice of the IUA occurs at a coordinate location behind the AR image of the IUA.

35. (previously presented) The electronic device of claim 28, wherein the image is a virtual reality (VR) image of an intelligent user assistant (IUA) that is located less than one meter away from the head of the user, and a voice of the IUA occurs at a coordinate location behind the VR image of the IUA.

36. (currently amended) An electronic system, comprising:

a display that displays an image that is located within a near-field distance from a head of a user viewing the image; and

one or more processors that process sound for the image with head-related transfer functions (HRTFs) to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance, wherein the coordinate location of the binaural sound continues to occur at the far-field distance located behind the image when the head of the user moves away from viewing the image and the image remains within the near-field distance from the head of the user.

37. (currently amended) The electronic system of claim 36 ~~37~~, wherein the display is an augmented reality (AR) display worn on the head of the user viewing the image, and the image is an AR image.

38. (currently amended) The electronic system of claim 36 ~~37~~, wherein the display is a virtual reality (VR) display worn on the head of the user viewing the image, and the image is an VR image.

39. (canceled)

40. (currently amended) The electronic system of claim 36 ~~37~~, wherein the display is on a smartphone held in a hand of the user.

Electronic Acknowledgement Receipt	
EFS ID:	44522896
Application Number:	17062637
International Application Number:	
Confirmation Number:	2878
Title of Invention:	User Experience Localizing Binaural Sound During a Telephone Call
First Named Inventor/Applicant Name:	Glen A. Norris
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-047 (CON3)
Receipt Date:	15-DEC-2021
Filing Date:	05-OCT-2020
Time Stamp:	13:10:18
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	48550	no	1
			1a5cd3ec06a1b53935b7c656ef09fa23170e e789		
Warnings:					

Information:					
2	Claims	claims.pdf	113277	no	6
			b9f11100b54fa6694843d3dd332369ac1180e88c		
Warnings:					
Information:					
Total Files Size (in bytes):			161827		
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. <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. <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. <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.					

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 OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT		
Application Number	17062637		
Filing Date	05-Oct-2020		
First Named Inventor	Glen Norris		
Attorney Docket Number	PSL-047 (CON3)		
Title of Invention	User Experience Localizing Binaural Sound During a Telephone Call		
☒ 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	
Glen Norris		100%	
Philip Lyren		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) 10805758			

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:		17062637		
Filing Date:		05-Oct-2020		
Title of Invention:		User Experience Localizing Binaural Sound During a Telephone Call		
First Named Inventor/Applicant Name:		Glen A. Norris		
Filer:		Philip Scott Lyren		
Attorney Docket Number:		PSL-047 (CON3)		
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.: 17062637

Filing Date: 05-Oct-2020

Applicant/Patent under Reexamination: Norris

Electronic Terminal Disclaimer filed on December 15, 2021

☒ 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:	44522841
Application Number:	17062637
International Application Number:	
Confirmation Number:	2878
Title of Invention:	User Experience Localizing Binaural Sound During a Telephone Call
First Named Inventor/Applicant Name:	Glen A. Norris
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-047 (CON3)
Receipt Date:	15-DEC-2021
Filing Date:	05-OCT-2020
Time Stamp:	13:08:45
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	E2021BED08410941
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	42454	no	3
			c303485f205d0e917ce29a910b74000fa320bd76		

Warnings:**Information:**

2	Fee Worksheet (SB06)	fee-info.pdf	38145	no	2
			174e0d4165af1561e469c6716c69b25003a0b4bd		

Warnings:**Information:**

Total Files Size (in bytes):			80599
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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.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 17/062,637		Filing Date 10/05/2020		☐ 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 \$240 =							
☐ 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	12/15/2021	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)			
	Total (37 CFR 1.16(i))	* 18	Minus	** 20		= 0		x \$50 =		0			
	Independent (37 CFR 1.16(h))	* 3	Minus	*** 3		= 0		x \$240 =		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	
		(Column 1)		(Column 2)		(Column 3)							
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR		PRESENT EXTRA		RATE (\$)		ADDITIONAL FEE (\$)			
	Total (37 CFR 1.16(i))	*	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".										/ALLYSON PURNELL/			
*** 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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UNITED STATES DEPARTMENT OF COMMERCE
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P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/062,637	10/05/2020	Glen A. Norris	PSL-047 (CON3)	2878
64021	7590	10/01/2021	EXAMINER	
PHILIP S. LYREN, PC			SAUNDERS JR, JOSEPH	
289 Woodland Avenue			ART UNIT	
Wadsworth, OH 44281			PAPER NUMBER	
			2652	
			MAIL DATE	
			DELIVERY MODE	
			10/01/2021	
			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

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA. This Office action is based on the communications filed October 13, 2020. Claims 21 – 40 are currently pending and considered below.

Double Patenting

2. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the “right to exclude” granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject

to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

3. Claims 21 – 27 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1, 2, 4, and 6 of U.S. Patent No. 10,805,758 B2. Although the claims at issue are not identical, they are not patentably distinct from each other because while obvious variations in wording are present claims 1, 2, 4, and 6 of U.S. Patent No. 10,805,758 B2 are narrower in scope and therefore anticipate all of the limitations required of claims 21 – 27.

Claim 21: U.S. Patent No. 10,805,758 B2 discloses a method, comprising: displaying video on a display of a portable electronic device (PED) (“watching images on a display of a portable electronic device (PED),” claim 1) held in a hand of a user; and processing, with one or more processors, sound for the video to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs behind the PED held in a hand of a user (“processing sound of the images into binaural sound with a digital signal processor (DSP) and with head-related transfer functions (HRTFs) having a coordinate location behind the PED held in the hand of the user while the display,” claim 1) and along a line-of-sight from the user to the PED (“wherein the coordinate location of the HRTFs does not occur at a location of

the PED but a location behind the PED along a line-of-sight from a head of the user to the location behind the PED,” claim 1).

Claim 22: U.S. Patent No. 10,805,758 B2 discloses the method of claim 21 further comprising: tracking, with one or more sensors, movement of a head of the user; and processing, with the one or more processors, the sound for the video such that the SLP for the sound for the video continues to have the coordinate location that occurs behind the PED held in the hand of the user as the head of the user moves (“tracking, with head tracking in the headphones worn by the user, head movements of the user with respect to the PED in a hand of the user watching the images on the display of the PED,” claim 1).

Claim 23: U.S. Patent No. 10,805,758 B2 discloses the method of claim 21 further comprising: processing, with the one or more processors, the sound for the video with far-field head-related transfer functions (HRTFs) while a location of the PED held in the hand of the user is less than one meter from the user and within a near-field distance (“wherein the DSP processes the sound with far-field HRTFs while the PED is located at a near-field distance from the face of the user,” claim 2, “the PED is less than one meter away from the face of the user,” claim 1).

Claim 24: U.S. Patent No. 10,805,758 B2 discloses the method of claim 21 further comprising: processing, with the one or more processors, the sound for the video with head-related transfer functions (HRTFs) having a coordinate location that matches the coordinate location of the SLP that occurs behind the PED held in the hand of the user and along the line-of-sight from the user to the PED (“processing sound of the images into binaural sound with a digital signal processor (DSP) and with head-related transfer functions (HRTFs) having a coordinate location behind the PED held in the hand of the user while the display,” claim 1, “wherein the coordinate location of the HRTFs does not occur at a

location of the PED but a location behind the PED along a line-of-sight from a head of the user to the location behind the PED,” claim 1)

Claim 25: U.S. Patent No. 10,805,758 B2 discloses the method of claim 21, wherein the one or more processors include a digital signal processor (DSP) that processes the sound for the video with far-field head-related transfer functions (HRTFs) while the PED is located at a near- field distance from a face of the user, and the PED is one of a smartphone and a tablet computer (“wherein the DSP processes the sound with far-field HRTFs while the PED is located at a near-field distance from the face of the user, and the PED is one of a smartphone and a tablet computer,” claim 2).

Claim 26: U.S. Patent No. 10,805,758 B2 discloses the method of claim 21, wherein the coordinate location of the SLP is located a distance (d_1) from a head of the user in which $d_1 > 1.0$ meter, and the PED is located a distance (d_2) from the head of the user in which $d_2 < 1.0$ meter (“wherein the location behind the PED occurs along the line-of-sight in which a distance (d_1) from the face of the user to the PED is $d_1 < 1.0$ meter and a distance (d_2) from the face of the user to the location behind the PED is $d_2 > 1.0$ meter,” claim 4).

Claim 27: U.S. Patent No. 10,805,758 B2 discloses the method of claim 21 further comprising: sensing, with one or more sensors in the PED, when the PED rotates in the hand of the user; and automatically switching, in response to the one or more sensors in the PED sensing rotation of the PED in the hand of the user, the binaural sound to stereo sound (“switching the binaural sound to stereo sound in response to detecting rotation of the PED,” claim 6).

Claim Rejections - 35 USC § 112

4. The following is a quotation of 35 U.S.C. 112(b):
(b) CONCLUSION.—The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the inventor or a joint inventor regards as the invention.

The following is a quotation of 35 U.S.C. 112 (pre-AIA), second paragraph:
The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 37 – 40 are rejected under 35 U.S.C. 112(b) or 35 U.S.C. 112 (pre-AIA), second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the inventor or a joint inventor (or for applications subject to pre-AIA 35 U.S.C. 112, the applicant), regards as the invention.
6. Claim 37 is dependent on itself. For examination purposes claim 37 will be interpreted as depending on claim 36. Claims 38 – 40 are rejected due to inherited dependency. For examination purposes claims 38 – 40 will also be interpreted as depending on claim 36 instead of claim 37 since claims 38 – 40 seem to mirror claims 29 – 31 and for example “the display... held in a hand” of claim 40 contradicts “the display... worn on the head” of claim 37. Appropriate correction and/or clarification is required.

Claim Rejections - 35 USC § 102

7. 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.
8. 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.

(a)(2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

9. Claim(s) 28 and 36 is/are rejected under 35 U.S.C. 102(a)(1) and 35 U.S.C. 102(a)(2) as being anticipated by Wu et al. (US 2005/0053249 A1), hereinafter Wu.

Claim 28: Wu discloses an electronic device, comprising: a display that displays an image that occurs within a near-field distance from a head of a user (see at least, "The audio/video device 102 represents any device, system, or part thereof that is capable of providing audio information to one or more speakers 104. The audio/video device 102 could also include functionality for receiving or generating video information for display on a television 110 or other display device. As particular examples, the audio/video device 102 could represent a television tuner or receiver, a compact disk ("CD") player, a digital versatile disk ("DVD") player, an audio tuner or receiver, a desktop, laptop, or server computer, or any other suitable device," Wu [0023]); and one or more processors that process sound for the image (see at least, "Audio information from the audio/video source 202 is provided to the audio processor 204. The audio processor 204 processes the audio information for presentation to one or more listeners 108. For example, the audio processor 204 could process the audio information to virtualize one or more virtual speakers 112. The audio processor 204 includes any hardware, software, firmware, or combination thereof for processing audio information. As particular examples, the audio processor 204 could include one or more microprocessors, digital signal processors ("DSPs"), field programmable gate arrays ("FPGAs"), application specific integrated circuits ("ASICs"), or any other suitable processor or processors," Wu [0030]) to generate binaural sound that has a sound localization point (SLP) with a

coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance (see at least, "In one aspect of operation, the audio/video device 102 is capable of rendering audio information to create the appearance of one or more "virtual" speakers 112a-112e. A virtual speaker 112 represents a direction from which the listener 108 believes sounds are originating. In other words, the two actual speakers 104 produce sounds that the listener 108 believes are coming from one or more directions other than from the speakers 104. For example, the audio/video device 102 could make it appear as if sounds are coming from a center speaker 112a directly in front of the listener 108," Wu [0024], "The virtualizer 210 receives the audio information from the audio/video source 202 and processes the audio information to virtualize one or more speakers 112. For example, the virtualizer 210 could process the audio information to virtualize a speaker 112a directly in front of the listener 108," Wu [0032], FIG. 1).

Claim 36: Wu discloses an electronic system, comprising: a display that displays an image that is located within a near-field distance from a head of a user viewing the image (see at least, "The audio/video device 102 represents any device, system, or part thereof that is capable of providing audio information to one or more speakers 104. The audio/video device 102 could also include functionality for receiving or generating video information for display on a television 110 or other display device. As particular examples, the audio/video device 102 could represent a television tuner or receiver, a compact disk ("CD") player, a digital versatile disk ("DVD") player, an audio tuner or receiver, a desktop, laptop, or server computer, or any other suitable device," Wu [0023]); and one or more processors that process sound for the image (see at least, "Audio information from the audio/video source 202 is provided to the audio processor 204. The audio processor 204 processes the audio information for presentation to one or more listeners 108. For example, the audio processor 204 could process the audio information to

virtualize one or more virtual speakers 112. The audio processor 204 includes any hardware, software, firmware, or combination thereof for processing audio information. As particular examples, the audio processor 204 could include one or more microprocessors, digital signal processors ("DSPs"), field programmable gate arrays ("FPGAs"), application specific integrated circuits ("ASICs"), or any other suitable processor or processors," Wu [0030]) with head-related transfer functions (HRTFs) (see at least, "In some embodiments, the virtualizer 210 makes use of the characteristics of HRTFs during the virtualization process," Wu [0036]) to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance (see at least, "In one aspect of operation, the audio/video device 102 is capable of rendering audio information to create the appearance of one or more "virtual" speakers 112a-112e. A virtual speaker 112 represents a direction from which the listener 108 believes sounds are originating. In other words, the two actual speakers 104 produce sounds that the listener 108 believes are coming from one or more directions other than from the speakers 104. For example, the audio/video device 102 could make it appear as if sounds are coming from a center speaker 112a directly in front of the listener 108," Wu [0024], "The virtualizer 210 receives the audio information from the audio/video source 202 and processes the audio information to virtualize one or more speakers 112. For example, the virtualizer 210 could process the audio information to virtualize a speaker 112a directly in front of the listener 108," Wu [0032], FIG. 1).

Allowable Subject Matter

10. Claims 29 – 35 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

11. Any inquiry concerning this communication or earlier communications from the examiner should be directed to JOSEPH SAUNDERS whose telephone number is (571)270-1063. The examiner can normally be reached on Monday-Thursday, 9:00 a.m. - 4 p.m., EST.

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, Ahmad Matar can be reached on (571)272-7488. 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.

/JOSEPH SAUNDERS JR/
Primary Examiner, Art Unit 2652

<i>Notice of References Cited</i>	Application/Control No. 17/062,637		Applicant(s)/Patent Under Reexamination Norris et al.	
	Examiner JOSEPH SAUNDERS		Art Unit 2652	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-20050053249-A1	03-2005	Wu, Yuan	H04S5/005	381/310
*	B	US-20150245159-A1	08-2015	Osman; Steven	H04S7/304	381/303
*	C	US-20090169037-A1	07-2009	Park; Youngjin	H04R5/02	381/309
*	D	US-20160212272-A1	07-2016	Srinivasan; Sriram	H04N21/439	1/1
*	E	US-20090041254-A1	02-2009	Jin; Craig	H04S7/304	381/1
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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. 20210928

<i>Search Notes</i> 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

CPC - Searched*		
Symbol	Date	Examiner
H04S7/303	09/28/2021	/JS/
G06K9/00228	09/28/2021	/JS/
G06K9/00248	09/28/2021	/JS/
G06K9/00288	09/28/2021	/JS/
G06K9/22	09/28/2021	/JS/
H04N5/232	09/28/2021	/JS/
H04N5/23219	09/28/2021	/JS/
H04N7/141	09/28/2021	/JS/
H04N7/147	09/28/2021	/JS/
H04N7/15	09/28/2021	/JS/
H04S7/40	09/28/2021	/JS/
H04N2007/145	09/28/2021	/JS/
H04S2420/00	09/28/2021	/JS/

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.

/JS/ Primary Examiner, Art Unit 2652	
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<i>Search Notes</i> 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

Search Notes		
Search Notes	Date	Examiner
Search Notes: 16/354182	09/28/2021	/JS/
EAST: Text of All Databases	09/28/2021	/JS/
Inventor (No Assignee of Record)	09/29/2021	/JS/

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

/JS/ Primary Examiner, Art Unit 2652	
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<i>Index of Claims</i> 	Application/Control No. 17/062,637	Applicant(s)/Patent Under Reexamination Norris et al.
	Examiner JOSEPH SAUNDERS	Art Unit 2652

✓	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	09/29/2021								
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	39	✓								
	40	✓								

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
S1	115	(US-20170295278-\$ or US-20100316232-\$ or US-20170366914-\$ or US-20170366913-\$ or US-20170332186-\$ or US-20160183011-\$ or US-20160142848-\$ or US-20160183024-\$ or US-20130041648-\$ or US-20120093320-\$ or US-20090041254-\$ or US-20070110265-\$ or US-20150010160-\$).did. or (US-9584653-\$ or US-9900555-\$ or US-8351589-\$ or US-9961208-\$ or US-9749473-\$ or US-9955279-\$ or US-9584942-\$ or US-9602946-\$ or US-9037468-\$ or US-9530426-\$ or US-6760447-\$ or US-8627213-\$ or US-9368117-\$ or US-9426589-\$).did. or (WO-2007045016-\$).did. (US-20170295278-\$ or US-20090041254-\$ or US-20140079212-\$ or US-20060274901-\$ or US-20030044002-\$ or US-20180091921-\$ or US-20150181355-\$ or US-20150049892-\$ or US-20180027349-\$ or US-20170245088-\$ or US-20130041648-\$ or US-20110153043-\$ or US-20110109798-\$ or US-20090169037-\$ or US-20090122995-\$ or US-20170332186-\$ or US-20180041849-\$ or US-20170094440-\$ or US-20050135643-\$ or US-20180343534-\$).did. or (US-7664272-\$ or US-9510112-\$ or US-9307331-\$ or US-8155358-\$).did. or (GB-2542609-\$).did. (US-20180343534-\$ or US-20190335287-\$ or US-20190250875-\$ or US-20190215636-\$ or US-20180164588-\$ or US-20160239252-\$ or US-20150304790-\$ or US-20160379660-\$ or US-20180046431-\$ or US-20160212272-\$ or US-20180027349-\$ or US-20150245159-\$).did. or (US-10178493-\$ or US-9998847-\$ or US-10051402-\$ or US-10219095-\$ or US-9591427-\$).did. or (US-20180343534-\$).did.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 10:37
S2	19	S1 and line adj2 sight	US-PGPUB; USPAT; USOCR; FPRS;	OR	ON	2021/09/28 10:38

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S3	149	(H04S7/303 G06K9/00228 G06K9/00248 G06K9/00288 G06K9/22 H04N5/232 H04N5/23219 H04N7/141 H04N7/147 H04N7/15 H04S7/40 H04N2007/145 H04S2420/00) and (sound near2 localiz\$5) and (line adj2 sight)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 10:51
S4	53	(H04S7/303 G06K9/00228 G06K9/00248 G06K9/00288 G06K9/22 H04N5/232 H04N5/23219 H04N7/141 H04N7/147 H04N7/15 H04S7/40 H04N2007/145 H04S2420/00) and (sound near2 localiz\$5) and (behind near5 (display image device))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 13:06
S5	52	binaural and (sound near2 localiz\$5) same (behind near5 (display image device))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/28 13:24
S6	15	("20050105442" "20060098830" "20060120533" "20080008326" "20080013746" "20080226084" "20090034772" "20090123007" "20110144783" "20120070021" "20140064517" "20150215721" "4199658" "6442277").PN. OR ("10721577" "2016/0088393" "2018/0007485" "2020/0084562" "9788120").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2021/09/28 13:36
S7	3	(11/574410 12/045668 12/271289).APP.	USPAT; USOCR	OR	ON	2021/09/28 13:43
S8	83	("20030026441" "20030086572" "20050053249" "20050117753" "20050117762" "20060045295" "20060062410" "20060126878" "20060210101" "20060269070" "20060280323" "20070030976" "20070154019" "20070217621" "20070230724" "20070286427" "20080101631" "20080165979" "20080226084" "20080273721" "20090010455" "20090028358" "20100189267" "5109415" "5440639" "5666425" "5761315" "5799094" "5870484" "5999630" "6243476" "6430294" "7113609" "7130430" "7545946" "7561706" "7577260"	US-PGPUB; USPAT; USOCR	OR	ON	2021/09/28 13:43

		"7606380" "7929709" "8041060" "8170245" "8223992").PN. OR ("2008/0226084" "2009/0034772" "2009/0123007" "8005245" "8428268" "8494189").URPN.				
S9	410	((("NORRIS") near3 ("Glen")) OR ((("LYREN") near3 ("Philip")))).INV.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	ON	2021/09/29 17:35
S10	41	binaural and (sound near2 localiz\$5) and (behind near5 (display image device)) and (line adj2 sight)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2021/09/29 18:38

9/29/2021 7:10:19 PM

C:\Users\jsaunders1\Documents\EAST\Workspaces\17_062637_1_User Experience Localizing Binaural Sound During a Telephone Call.wsp

Bibliographic Data

Application No: 17/062,637

Foreign Priority claimed: ☐ Yes ☒ No

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

☐ Met After Allowance

Verified and Acknowledged: /JOSEPH SAUNDERS/

Examiner's Signature

Initials

Title: User Experience Localizing Binaural Sound During a Telephone Call

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/05/2020	700	2652	PSL-047 (CON3)
RULE			

APPLICANTS

INVENTORS

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Philip Scott Lyren, Bangkok, THAILAND

CONTINUING DATA

This application is a CON of 16354182 03/15/2019 PAT 10805758

16354182 is a CON of 16246501 01/13/2019 PAT 10791409

16246501 is a CON of 15603552 05/24/2017 PAT 10219095

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/062,637	10/05/2020	Glen A. Norris	PSL-047 (CON3)

CONFIRMATION NO. 2878

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

PUBLICATION NOTICE



OC000000122790381*

Title:User Experience Localizing Binaural Sound During a Telephone Call

Publication No.US-2021-0021952-A1

Publication Date:01/21/2021

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.

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In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently <https://portal.uspto.gov/pair/PublicPair>. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 17/062,637			
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	80		N/A			
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	350		N/A			
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	400		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 240 =	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).			0.00					
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	830		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.									



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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
17/062,637	10/05/2020	2654	830	PSL-047 (CON3)	20	3

CONFIRMATION NO. 2878

FILING RECEIPT



CC000000120840579

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

Date Mailed: 10/14/2020

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)

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

Applicant(s)

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

Power of Attorney:

Philip Lyren--40709

Domestic Priority data as claimed by applicant

This application is a CON of 16/354,182 03/15/2019 PAT 10805758
which is a CON of 16/246,501 01/13/2019 PAT 10791409
which is a CON of 15/603,552 05/24/2017 PAT 10219095

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: No

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: 10/14/2020

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/062,637**

Projected Publication Date: 01/21/2021

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

User Experience Localizing Binaural Sound During a Telephone Call

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.

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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).

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventors:	Glen A. Norris, et al.	Examiner:	Joseph Saunders Jr.
Serial No.:	17/062,637	Group Art Unit:	2655
Filed:	5 October 2020	Docket No.:	PSL-047 (CON3)
Title:	Providing Binaural Sound Behind an Image Being Displayed with an Electronic Device		

PRELIMINARY AMENDMENT FOR CONTINUING APPLICATION

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

Please enter the following amendments for this continuing application.

Amendments to the Specification

The Title and the Abstract are amended. No new matter is entered.

Amendments to the Claims

Claims 1 – 20 are canceled. Claims 21 – 40 are newly added. No new matter is entered.

Respectfully submitted,

/Philip S. Lyren #40,709/

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

Amendments to the Specification

Please amend the Title of the invention as follows:

Providing Binaural Sound Behind an Image Being Displayed with an
Electronic Device ~~Improving a User Experience Localizing Binaural Sound During~~
~~a Telephone Call~~

Amendments to the Specification

Please amend the Abstract of the invention as follows:

A electronic device displays an image that has sound. One or more processors process the sound for the image into binaural sound for a user. The binaural sound has a sound localization point (SLP) with a coordinate location that occurs behind the image while the image is located a near-field distance from a head of the user. Methods and apparatus improve a user experience during telephone calls or other forms of communication in which a listener localizes electronically generated binaural sounds. The sound is convolved or processed to a location that is behind or near a source of the sound so that the listener perceives the location of the sound as originating from the source of the sound.

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, comprising:

displaying video on a display of a portable electronic device (PED) held in a hand of a user; and

processing, with one or more processors, sound for the video to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs behind the PED held in the hand of the user and along a line-of-sight from the user to the PED.

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

tracking, with one or more sensors, movement of a head of the user; and
processing, with the one or more processors, the sound for the video such that the SLP for the sound for the video continues to have the coordinate location that occurs behind the PED held in the hand of the user as the head of the user moves.

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

processing, with the one or more processors, the sound for the video with far-field head-related transfer functions (HRTFs) while a location of the PED held

in the hand of the user is less than one meter from the user and within a near-field distance.

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

processing, with the one or more processors, the sound for the video with head-related transfer functions (HRTFs) having a coordinate location that matches the coordinate location of the SLP that occurs behind the PED held in the hand of the user and along the line-of-sight from the user to the PED.

25. (new) The method of claim 21, wherein the one or more processors include a digital signal processor (DSP) that processes the sound for the video with far-field head-related transfer functions (HRTFs) while the PED is located at a near-field distance from a face of the user, and the PED is one of a smartphone and a tablet computer.

26. (new) The method of claim 21, wherein the coordinate location of the SLP is located a distance (d_1) from a head of the user in which $d_1 > 1.0$ meter, and the PED is located a distance (d_2) from the head of the user in which $d_2 < 1.0$ meter.

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

sensing, with one or more sensors in the PED, when the PED rotates in the hand of the user; and

automatically switching, in response to the one or more sensors in the PED sensing rotation of the PED in the hand of the user, the binaural sound to stereo sound.

28. (new) An electronic device, comprising:

a display that displays an image that occurs within a near-field distance from a head of a user; and

one or more processors that process sound for the image to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance.

29. (new) The electronic device of claim 28, wherein the image is an augmented reality (AR) image, and the display is included with electronic glasses worn on the head of the user.

30. (new) The electronic device of claim 28, wherein the image is a virtual reality (VR) image, and the display is included with a head mounted display worn on the head of the user.

31. (new) The electronic device of claim 28, wherein the one or more processors include a digital signal processor (DSP) that processes the sound for the image with far-field head-related transfer functions (HRTFs) while the electronic device

is located at the near-field distance from the head of the user, and the electronic device is one of a smartphone and a tablet computer.

32. (new) The electronic device of claim 28 further comprising:

one or more sensors that detect rotation of the electronic device, wherein the binaural sound automatically switches to stereo sound in response to the one or more sensors detecting the rotation of the electronic device.

33. (new) The electronic device of claim 28, wherein the binaural sound automatically switches to stereo sound in response to the electronic device detecting a change to a head orientation of the user that exceeds a threshold value in an azimuth direction.

34. (new) The electronic device of claim 28, wherein the image is an augmented reality (AR) image of an intelligent user assistant (IUA) that is located less than one meter away from the head of the user, and a voice of the IUA occurs at a coordinate location behind the AR image of the IUA.

35. (new) The electronic device of claim 28, wherein the image is a virtual reality (VR) image of an intelligent user assistant (IUA) that is located less than one meter away from the head of the user, and a voice of the IUA occurs at a coordinate location behind the VR image of the IUA.

36. (new) An electronic system, comprising:

a display that displays an image that is located within a near-field distance from a head of a user viewing the image; and

one or more processors that process sound for the image with head-related transfer functions (HRTFs) to generate binaural sound that has a sound localization point (SLP) with a coordinate location that occurs at a far-field distance located behind the image and along a line-of-sight from the user to the image while the display displays the image to the user at the near-field distance.

37. (new) The electronic system of claim 37, wherein the display is an augmented reality (AR) display worn on the head of the user viewing the image, and the image is an AR image.

38. (new) The electronic system of claim 37, wherein the display is a virtual reality (VR) display worn on the head of the user viewing the image, and the image is an VR image.

39. (new) The electronic system of claim 37, wherein the coordinate location of the binaural sound continues to occur at the far-field distance located behind the image when the head of the user moves away from viewing the image and the image remains within the near-field distance from the head of the user.

40. (new) The electronic system of claim 37, wherein the display is on a smartphone held in a hand of the user.

Electronic Acknowledgement Receipt	
EFS ID:	40823890
Application Number:	17062637
International Application Number:	
Confirmation Number:	2878
Title of Invention:	Improving a User Experience Localizing Binaural Sound During a Telephone Call
First Named Inventor/Applicant Name:	Glen A. Norris
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-047 (CON3)
Receipt Date:	13-OCT-2020
Filing Date:	
Time Stamp:	09:45:24
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	19834	no	1
			7718b827912efdc40853b64e9e689aeda2d c1e2f		
Warnings:					

Information:					
2	Specification	specification.pdf	24016	no	2
			56ca2f8214b79d7ef07e22094c350f1d82893dc7		
Warnings:					
Information:					
3	Claims	claims.pdf	45494	no	5
			8f0da6e69e270e5281835273e72277f6b8f513d2		
Warnings:					
Information:					
Total Files Size (in bytes):			89344		
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. <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. <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. <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.					

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UTILITY PATENT APPLICATION TRANSMITTAL <i>(Only for new nonprovisional applications under 37 CFR 1.53(b))</i>	Attorney Docket No.	PSL-047 (CON3)
	First Inventor	Glen A. Norris
	Title	Improving a User Experience Localizing Binaural Sound During a Telephone Call
	Express Mail Label No.	

APPLICATION ELEMENTS <i>See MPEP chapter 600 concerning utility patent application contents.</i>	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>81</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>11</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					
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Address					
City		State		Zip Code	
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Signature		/Philip Lyren, #40,709/		Date	
Name (Print/Type)		Philip Lyren		Registration No. (Attorney/Agent)	
				40,709	

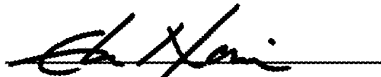
This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 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.

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USPTO**

As a named inventor, we hereby appoint Philip Scott Lyren (attorney having registration number 40,709) to prosecute the patent application having attorney docket number PSL-047 (entitled "Improving a User Experience Localizing Binaural Sound During a Telephone Call") and to transact all business in the Patent and Trademark Office connected therewith.

IN WITNESS WHEREOF, I hereunto set my hand:


Glen A. Norris

22 May 2017
Date


Philip Scott Lyren

22 May 2017
Date

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-047 (CON3)
		Application Number	
Title of Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

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Residence Information (Select One) ☐ US Residency ☒ Non US Residency ☐ Active US Military Service						
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	Philip	Scott	lyren			
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All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add						

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-047 (CON3)
		Application Number	
Title of Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		

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Application Information:

Title of the Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		
Attorney Docket Number	PSL-047 (CON3)	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	11	Suggested Figure for Publication (if any)	

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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

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-047 (CON3)
		Application Number	
Title of Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		

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Prior Application Status		Pending		Remove	
Application Number		Continuity Type		Prior Application Number	Filing Date (YYYY-MM-DD)
		Continuation of		16354182	2019-03-15
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16354182	Continuation of	16246501	2019-01-13	10791409	2020-09-29
Prior Application Status		Patented		Remove	
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16246501	Continuation of	15603552	2017-05-24	10219095	2019-02-26
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Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-047 (CON3)
		Application Number	
Title of Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		

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

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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	PSL-047 (CON3)
		Application Number	
Title of Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		

Applicant	1 Remove	
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section. Clear		
Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
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Address 1				
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		Application Number	
Title of Invention	Improving a User Experience Localizing Binaural Sound During a Telephone Call		

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Signature	/Philip Lyren, #40,709/		Date (YYYY-MM-DD)	2020-10-04
First Name	Philip	Last Name	Lyren	Registration Number
				40709

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)		Attorney Docket Number	PSL-047
		First Named Inventor	Glen A. Norris
		COMPLETE IF KNOWN	
☒ Declaration Submitted With Initial Filing	OR ☐ Declaration Submitted After Initial Filing (surcharge (37 CFR 1.16(f)) required)	Application Number	
		Filing Date	
		Art Unit	
		Examiner Name	

Improving a User Experience Localizing Binaural Sound During a Telephone Call

(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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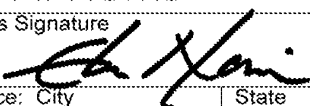
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[Page 1 of 2]

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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)					
Glen A. Norris					
Inventor's Signature 				Date (Optional)	
				22 May 2017	
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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	
Given Name (first and middle (if any))		Family Name or Surname	
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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
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Name of Additional Joint Inventor, if any:		☐ A petition has been filed for this unsigned inventor	
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Improving a User Experience Localizing Binaural Sound During a Telephone Call

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

Methods and apparatus improve a user experience during situations in which a listener localizes electronically-generated binaural sounds. The sound is convolved or
5 processed to a location that is behind or near a source of the sound so that the listener perceives the location of the sound as originating from the source of the sound.

Other example embodiments are discussed herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a method that improves a user experience while listening to binaural sound that localizes to a sound source in accordance with an example embodiment.

5

Figure 2 is a method that improves a user experience while listening to binaural sound that localizes to a sound source in accordance with an example embodiment.

Figure 3 is a method that improves a user experience while listening to binaural sound that localizes to a sound source in accordance with an example embodiment.

10

Figure 4 is a method that detects an action of a portable electronic device and changes sound in response to detection of the action in accordance with an example embodiment.

15

Figures 5A – 5H show a listener interacting with a handheld portable electronic device (HPED) to change sound between being provided in binaural sound and being provided in mono or stereo sound in accordance with an example embodiment.

Figures 6A and 6B show an electronic or computer system in which a listener hears voices from three different users whose voices localize externally to the listener as binaural sound to three different images on a display of an electronic device in accordance with an example embodiment.

20

Figure 7 shows an electronic or computer system in which two listeners are engaged in a telephone call in accordance with an example embodiment.

25

Figures 8A and 8B show an electronic or computer system in which a listener sits at a table and engages in a telephone call or other type of communication with two users via a portable electronic device in accordance with an example embodiment.

30

Figure 9 is a method that selects HRTFs based on a distance of a listener from a sound source in accordance with an example embodiment.

5 Figure 10 is a method that convolves, during a telephone call, a voice of a sound source to a location behind the sound source in accordance with an example embodiment.

10 Figure 11 is a computer system or electronic system in accordance with an example embodiment.

Figure 12 is a computer system or electronic system in accordance with an example embodiment.

DETAILED DESCRIPTION

Example embodiments include methods and apparatus that improve a user experience during a telephone call or other form of electronic communication.

- 5 One problem with electronically generated binaural sound or three-dimensional (3D) sound rendering is that listeners have a difficult time determining a location where the sound originates when this location is close to the listener. For example, when the location of the origination of binaural sound is convolved to less than one meter from the person (considered to be “near-field”) it may be more difficult for the person to
- 10 determine a location or direction of a binaural sound. Whereas, a listener may have more success in external localization when the binaural sound is processed to originate from about one meter or more from the person (considered to be “far-field”).

- Head related transfer functions (HRTFs) describe how a sound wave changes as it
- 15 interacts with the torso, head, and pinnae of the listener. HRTFs do not vary substantially in the far-field range. By contrast, HRTFs can vary significantly in the near-field range. Such variations can be significant depending on the frequency of the sound (e.g., sound below 500 Hz) as frequency at near-field distance has a large impact on interaural level difference (ILD). Further, modeling near-field virtual
- 20 auditory space with HRTFs can be quite complex.

- These issues become problematic when an electronic device attempts to convolve sound so the binaural sound originates to the listener in the near-field range. The listener may perceive the sound as originating from the wrong location or be unable
- 25 to localize an origin of the sound. Additionally, convolving sound with near-field HRTFs can be computationally complex and processor-intensive.

- Another problem with electronically generated binaural sound occurs when the perceived location of where the sound originates does not match a location of an
- 30 image of the sound. For example, a computer or electronic system convolves or processes a stream of sound or sound (e.g., a voice or sound from a game character

or object or other virtual sound source) from a video call or telephone software application, computer game, or a social VR (virtual reality) or AR (augmented reality) software application. The listener then hears the stream of sound as if the sound is originating from a certain point in space where an image is located in the physical or virtual environment around the listener. The effectiveness of the user experience is lost on the listener if the listener is not able to localize or hear the convolved or processed sound at the location of the image. This situation can occur, for example, when the image is located at a near-field distance from the listener or the image is occluded or not visible to the listener (e.g., occluded by a physical or virtual object).

At the source of the sound can be something visible (such as a real or virtual object that the listener sees) or at the sound source there may be no visual cue or image (such as a real or virtual object that the listener does not see). As such, instances arise when the location where the listener perceives an origin of sound does not match an image at the source of the sound or match the intended location for the sound. Example embodiments solve these problems and others in order to improve the user experience of the listener communicating, navigating, or operating with binaural sound in physical or virtual space.

Consider an example in which a listener wears a head mounted display or other wearable electronic device and sees a visible source of the sound that is an image of a caller during a telephone call. The voice of the caller is not heard to originate from the image shown with the display, but instead originates from a location away from the image. This situation would not provide the listener with a credible user experience since the voice of the caller is not originating at the image of the caller.

Binaural sound or 3D audio becomes more realistic when a perceived location of where the sound originates matches or aligns with a visible source of the sound, such as an image or object. The realism and user experience significantly decrease when the location of the origination of the sound does not align with a visible source of the sound.

The problem of aligning a binaural sound with a visible source of the sound becomes exacerbated when the source of the sound is within a near-field distance of the listener. In this situation, even when the sound is convolved with near-field HRTFs in order for the sound to originate from the near-field visible source of the sound, the
5 convolved sound may fail to accurately localize to a listener due to the lower reliability of externalization from near-field HRTFs relative to far-field HRTFs.

These problems can also occur when the source of the sound is not visible but the listener knows a location of the source of sound. For example, a listener sees and
10 talks with another person and then momentarily looks away in another direction. During the moment of looking away, the listener does not see the other person, but knows a precise location or area where he or she is located. The listener expects a voice from the other person to originate from the location.

15 One way to convolve binaural sound is to convolve the sound to a location where the sound source is visually perceived (e.g., convolve the sound to the coordinate location of the image, virtual sound source (VSS), avatar, or display). In some instances, it may be difficult, undesirable, or impossible to convolve the sound to the visually perceived location of the sound source. For example, the electronic device
20 convolving the sound is not able to select HRTFs with coordinates that match coordinates of the sound source or a location of the sound source as presented to the listener. Such HRTFs may not exist. Further, selecting or deriving such HRTFs may be process-intensive or have another disadvantage. So where should sound be convolved to localize in these instances? What HRTFs should be selected, if any?

25 Example embodiments solve these problems and improve the user experience of a listener externally localizing binaural sound.

Electronic devices with example embodiments displaying the sound source or
30 providing sound may not include speakers to generate sound or may include speakers but the electronic device does not generate sound with the speakers.

- Instead, a listener may receive the sound from a handheld or portable electronic device, such as headphones, earphones, earbuds, a wearable electronic device, an electronic device that provides sound from bone conduction, or another type of electronic device that provides binaural sound to a listener. Further, the electronic
- 5 devices may include wireless and wired electronic devices, such as wireless earphones, wireless headphones, electronic glasses with earphones or earbuds, a head mounted display (HMD) or optical head mounted display (OHMD) with earphones or earbuds, a smartphone with wireless earphones or earbuds, etc.
- 10 Electronic devices of example embodiments are not required to emit sound to a listener in a conventional manner (e.g., with speakers at the electronic device that transmit sound through the air to the listener). For example, an electronic device is a smartphone, computer, television, display, or other electronic device with speakers muted, decoupled, or powered off. Nevertheless, it may be useful or convenient for a
- 15 listener to localize sound at the electronic device. For instance, binaural sound localizes to an image displayed on or through the display of the electronic device when such an electronic device is not providing sound to the listener in the conventional manner.
- 20 Although sound may not emanate from speakers of an electronic device in a conventional way, example embodiments process the sound to appear to the listener to originate or emanate from a sound source or particular location (e.g., at the electronic device, behind the electronic device, in front of the electronic device, to a side of the electronic device, or to another location). The binaural sound causes the
- 25 listener to perceive the sound as originating from or localizing at the sound source even though the sound source emits no sound through the air. Instead, the listener hears the convolved binaural sound through earphones, earbuds, headphones, wearable electronic device, or another apparatus.
- 30 One or more processors (such as a digital signal processor or DSP) processes or convolves the sound to a location that is not coincident with or not at the location of

the sound source. For example, a DSP processes the sound to localize to a coordinate location that does not match a coordinate location of the sound source. Nevertheless, the listener hears the sound as originating from or believes that the sound originates from the sound source. Sound originates to the listener at a sound localization point (SLP) that is coincident with or at the sound source. The SLP experienced by the listener is influenced but not dictated by the HRTF pair convolving the sound. Likewise a visual image that a listener associates with an auditory event also influences the SLP. For example, a sound of a dog barking is convolved to a location in front of a listener at a distance of three meters, and the sound is stored in a file. The sound file is played to a blindfolded listener who, externalizing the binaural sound, approximates that a dog is three meters away. The distance of the SLP of the barking sound is three meters. Consider a listener without a blindfold, also hearing the sound file of the barking dog convolved to the distance of three meters, and in addition, seeing an image of a barking dog in front of him or her two meters away. In this case the listener, seeing the image of the dog associated with the auditory event of the sound of the dog, localizes the barking sound to the associated sound source (at two meters). Although a single sound file is played, the SLP for the seeing listener is two meters from him or her, whereas the SLP for the blindfolded listener is three meters from him or her. Thus a sound convolved with a certain pair of HRTFs is externalized at different SLPs depending on the circumstances, situation, and/or listener.

Example embodiments include methods and apparatus that help to solve these problems and other problems with binaural sound. Example embodiments improve realism and the user experience of a listener listening to binaural sound when the sound source or source of the sound is close to the listener, such as being in a near-field range from the listener. Further, example embodiments are applicable to both visible and non-visible sound sources.

One or more of several different techniques of executing hardware and/or software convolve the sound so the listener believes that the sound originates from the sound

- source when in fact the sound is convolved to a different location. These techniques include placing or positioning the origination point of the sound on a line-of-sight with the sound source, placing the origination of the sound on an imaginary line from the head of the listener (e.g., a point between the ears of the listener) to the sound
- 5 source, placing the origination of the sound behind the sound source, simulating the direction of the sound as though coming from the direction of the sound source, adjusting a volume of the sound to be commensurate with the distance to the sound source, and executing other example embodiments discussed herein.
- 10 Figure 1 is a method that improves a user experience while listening to binaural sound that localizes to a sound source.

Block 100 states display, with an electronic device, a sound source to a person.

- 15 In an example embodiment, the sound source is visible to the person, such as being in a field-of-view or line-of-sight of the person. For instance, the listener sees an image on, through, or with a display of an electronic device. Alternatively, the sound source is not visible to the person, such as not being in a field-of-view or line-of-sight of the person. For instance, an image or a virtual object is shown on an electronic
- 20 display as behind the listener, in another room, or presently not visible. As another example, the electronic display is behind the listener, in another room, or presently not visible.

- By way of example, the electronic device is a smartphone, a tablet computer, a
- 25 notebook or laptop computer, a desktop computer, a television, a display, an electronic watch, a screen, a portable electronic device (PED), a handheld portable electronic device (HPED), a non-portable computer or non-portable electronic device. For instance, the electronic device is a smartphone or tablet computer held in a hand of the person, a laptop computer or tablet computer or desktop computer resting on a
- 30 surface in front of the person, an electronic watch with a display on a wrist of the person, a portable electronic device on a lap of the person while the person sits in a

chair or passenger seat, a television in a home, store, or other public place, a home appliance, a display mounted on or affixed to an object (such as a wall or dashboard), or an advertising display (such as an edge display or counter display or other electronic device that provides advertisements to people).

5

For example, the sound source is an image, such as a video, a picture, an AR image (e.g., an image of a virtual sound source), a VR image or a combination of one or more of these images. For instance, the sound source is a real-time video of a person captured with a camera and displayed to the person, an AR image displayed with a
10 wearable electronic device (e.g., electronic glasses or a smartphone mounted to a wearable head mount), a VR image displayed with a head mounted display (HMD), a two-dimensional (2D) image on a flat display (e.g., a TV or an advertisement display), a 3D image, a stationary image, a moving image, a recorded image, a real-time image, a hologram, or another image that is generated, reproduced, or displayed with
15 an electronic device.

Block 110 states improve the user experience of the person by processing sound of the sound source with sound localization information (SLI) that positions the sound to a location that is located behind a location of the sound source so the person
20 perceives an origin of the sound as originating from the location at the sound source.

The position to where the sound is convolved is not the location of the sound source. Instead, the location where the sound is convolved is behind the sound source from the point-of-view of the listener.

25

As noted, in some instances, it may be difficult, undesirable, or impossible to convolve sound to the location of the sound source. In these instances, an example embodiment selects HRTF pairs having coordinates of a position behind the sound source.

30

By way of example, the sound source is a display of a handheld portable electronic device (HPED) that the listener holds (e.g., a smartphone or tablet computer). The HPED displays an image of a talking person while the display is one to two feet in front of a face of the listener. The HPED selects a HRTF pair that has coordinates in a far-field range about 1.0 meter from the face of the listener. A processor in the HPED processes a voice of the talking person so the voice localizes to the coordinate location of the HRTF pair. The coordinate location is in front of the face of the listener, directly behind the image of the talking person on the display of the HPED, and located about 1.0 meter away from the face of the talking person. The listener hears or believes that the voice of the talking person originates from the image of the talking person on the display that is one to two feet away. This situation occurs even though the display is closer to the face of the listener than the selected coordinate location of the HRTFs being executed to convolve the voice of the talking person.

The listener thus perceives that the sound originates from the image even though the sound is convolved to originate from a position that is behind the image. This situation occurs because listeners are accustomed to hearing sound originate from a physical auditory event, such as at a physical object. Listeners consciously or unconsciously try to visually locate an object or event that corresponds to the sound and to associate or to place the origination of the sound at the object. Thus, even though the sound does not actually originate from the image, the brain ignores or reconciles a difference of position, resulting in the origin of the sound being localized at the image. When coordinates of the localization point occur beyond and behind the image, the sound localizes to the listener at the image. This situation also occurs because listeners have a difficult time in accurately judging exact or precise distances to an origin of sound, especially when the sound is not a voice and/or when the source of the sound is not visible to the listener. One or more example embodiments take advantage of these observations and trick the listener into believing that the sound originates from the sound source when in fact the sound is convolved to originate from a location that is behind the sound source.

Consider an example in which a processor processes sound with HRTFs having coordinates of a far-field location even though the location of the source of the sound (e.g., an image being displayed) is a near-field distance from the listener. In this example, the sound originates from behind the source of the sound. During this time, however, the listener perceives the sound as originating from the location at the source of the sound and not behind the source of the sound.

Consider an example embodiment that improves a user experience when an electronic device, an image, or an object is a source of sound that is located within a near-field distance from the person (e.g., less than one meter away from a face of the person). A processor processes or convolves the sound with far-field HRTFs so the sound originates to a listener beyond yet behind the electronic device, the image, or the object. Nevertheless, the listener believes that the sound originates from the location of the electronic device, the image, or the object.

In an example embodiment, a method improves a user experience during a video call or a telephone call between a person and another person when the person uses a HPED that is located within a near-field distance from the person. For instance, the person holds the HPED in front of his or her face to see a real-time video or image of the other person. For example, a camera captures video of the other person, and the person sees the video or an AR or VR image based on the video. One or more processors convolve a voice of the other person with far-field HRTFs to a coordinate location in empty space behind the HPED located at the near-field distance. The person would otherwise localize the voice of the other person at the coordinate location of the HRTFs in empty space. However, the person perceives the voice of the other person as originating from the HPED when the HPED is located between the face of the person and the location where the voice of the other person is convolved to the person. Thus, the person hears the sound as originating from the HPED at a near-field distance even though the coordinate location of the HRTFs is located behind the HPED at a far-field distance.

Consider an example embodiment in which the sound source is at an HPED or smartwatch and not an image of a person; and the sound at the sound source is a chime or alert sound. For instance, a listener wears headphones that are coupled to multiple electronic devices that are within near-field and/or far-field distances. When the listener hears an alert sound, music, or announcement issued by one of the electronic devices, the example embodiment convolves the sound to a far-field point on the line extending from his or her head toward the electronic device that issued the sound. Processing the sound in this manner allows the listener to monitor which one of the electronic devices issues the sound.

Consider an example embodiment that convolves or processes sound so the coordinates to where the sound is located occur behind an image that is the source of sound to the listener. For example, a head of a listener is located at an origin with spherical coordinates of (0, 0, 0), and an electronic device with a display is located at (0.5 m, 20°, 20°) with respect to a forward-looking direction of the listener. In order to deliver binaural sound that will be perceived as originating from the display of the electronic device, sound could be convolved with a pair of HRTFs corresponding to the location of the electronic device (0.5 m, 20°, 20°). The location of the electronic device, however, is a near-field location with respect to the location of the listener. HRTFs with the near-field location may not be known, may be too process-intensive to convolve with a processor, or may fail to generate reliable audial cues to result in a sound localization point (SLP) for the listener. Instead of processing the sound with the near-field HRTFs, the electronic device selects HRTFs having coordinates that are located at a far-field distance with respect to the listener. For example, the electronic device selects different HRTFs with spherical coordinates of (1.2 m, 20°, 20°). The coordinate location of the different HRTFs occur directly behind a center of the electronic device. Specifically, a distance from the listener to the location to which the different HRTFs correspond is 1.2 m, whereas a distance from the listener to the location of the electronic device is 0.5 m. Further, the location of the coordinates of the different HRTF pair and the location of the coordinates of the electronic device occur on a straight line to a center of the head of the listener (e.g., inside the head of

the listener and between his or her ears). Processing the sound with the different HRTFs at the far-field location (as opposed to the near-field location) is less process-intensive and improves the chances of the listener localizing the sound at the sound source. Further, since the location of the coordinate location of the different HRTFs occur directly behind the coordinate location of the electronic device, the listener perceives the sound as originating from the electronic device and not from behind the electronic device.

An example embodiment convolves sound with HRTFs having coordinates that are behind the source of the sound. A distance from the listener to the location of the coordinates of the HRTFs is greater than a distance from the listener to the source of the sound. For example, a processor convolves or processes the sound to originate at a coordinate location that occurs behind a coordinate location of the visible source of the sound. In some instances, the visible source of the sound obstructs a view of the location to where the sound is convolved. For instance, if an image appears on a display and the sound originates from a location behind the display, the listener would not be able to see the location to where the sound is convolved since the display blocks the listener from seeing the location.

Consider an example in which the source of the sound is an electronic device with a display, and the listener sees an image as the visible source of the sound on or through the display. For example, the listener sees a real-time video, a picture, an augmented reality (AR) image, a virtual reality (VR) image, or another object or image that the listener attributes to a sound source. The electronic device, however, is closer than one meter to a face of the listener and, as such, is within a near-field distance from the listener. Instead of convolving the sound with near-field HRTFs, the electronic device convolves the sound with far-field HRTFs. The electronic device selects coordinates of these far-field HRTFs so the location of where the listener hears the sound coming from is behind the electronic device. The location is on a line-of-sight or an imaginary line that extends from the head of the listener to a location where the image is shown on or through the display. The listener observes

that the binaural sound originates from the image even though the sound is convolved to a location that is behind the image.

5 Figure 2 is a method that improves a user experience while listening to binaural sound that localizes to the sound source.

Block 200 states display, with an electronic device, a sound source to a person.

10 The electronic device provides or presents the sound source to the person, such as displaying an image on, with, or through a display of the electronic device (see block 100 for further examples).

15 Block 210 states improve the user experience of the person by processing sound of the sound source with sound localization information (SLI) that positions the sound to a location that is on a line-of-sight from the person to the sound source so the person perceives an origin of the sound as originating from the location of the sound source.

20 The location where the sound is convolved or positioned is not the location of the sound source. Instead, the location where the sound is convolved is before the sound source or after the sound source and on the line-of-sight from the listener to the sound source.

25 As noted, in some instances, it may be difficult, undesirable, or impossible to convolve sound to the location of the sound source. In these instances, an example embodiment selects HRTFs with coordinates that exist on an imaginary line that extends from a head of the listener through the sound source. For instance, the imaginary line exists as a line-of-sight when a head of the listener is facing the sound source and the eyes of the listener are looking toward the sound source. As another example, the line extends from a location inside the head of the listener (e.g.,
30 between the eyes of the listener) to an image or object representing the sound source. In this instance, the listener is not required to be looking at the sound source, and

hence calculations based on a direction where the eyes of the listener are looking are not required. Consider an example in which the listener knows the location or direction of the sound source without actively seeing the sound source (e.g., the listener has already seen the sound source in an earlier field-of-view, the listener anticipates the location of the sound source, the listener has not and/or does not see the sound source but was or is informed of the location of the sound source in another way). The sound is convolved upon an imaginary line in the direction coinciding with the sound source, and hearing the sound positioned on the line produces the perception of the sound originating at the known position of the sound source that is also on the line.

When sound is convolved to originate on or near the line, then the listener is more likely to understand or to comprehend that the sound is attributed to or originates from the position of the sound source. This situation occurs when the sound is convolved to localize on or near the line in front of the sound source or behind the sound source. Thus, two separate optional areas exist that are not located at the location of the sound source and for which HRTF pairs of associated coordinates may be available to execute convolution of the sound. One option is to select HRTFs with coordinates on the line in front of or before the sound source. In this option, the location of the coordinates of the HRTFs is between the face or head of the listener and the sound source. Another option is to select HRTFs with coordinates on the line behind or after the sound source. In this option, the sound source is between the face or head of the listener and the location of the coordinates of the HRTFs.

A processor processes or convolves the sound to originate at a location that is on an imaginary line-of-sight that extends from the listener to the source of the sound. Consider an example in which the source of sound is an image displayed on a display of an electronic device (e.g., a display of a smartphone) or displayed as a VR or AR image with a wearable electronic device. A coordinate location of where the sound is convolved on the line-of-sight is located before the image, at the image, and/or behind the image. As noted, selecting the coordinate location at the image

may not be possible, efficient, or desirable. As an alternative, example embodiments select coordinate location(s) before and/or after the image and on the line-of-sight.

The sound of the sound source may be convolved to multiple locations along the line simultaneously, emphasizing or highlighting the sound. Highlighting the sound

- 5 improves the experience of the listener in establishing the direction of the localization and/or identifying the sound source to which the sound is attributed.

An example embodiment convolves the sound to varied locations on the line during the playing of the sound. During the playing of the sound, the example embodiment

- 10 monitors the response of the listener to the localization in order to establish a best or better location that improves the accuracy of the localization and experience of the listener. For example, for any particular sound that is convolved to localize at (r, θ, ϕ) on the line extending from the head of the listener, there is an optimal distance R that improves the experience of binaural sound for each listener and each sound source.

- 15 For example, for some sounds, sound sources or images, listeners, and directions (θ, ϕ) , the optimal value of R may be larger (e.g., improving the positional realism of the experience of the listener in establishing the direction of the localization for sound sources that require accuracy of position) or may be smaller (e.g., increasing the intelligibility or volume of the sound for sound that carries more data such as speech).

- 20 An example embodiment varies the distance r and gathers active or passive feedback from the listener in order to further adjust r to find the optimal R for each sound source. Finding an optimal R for each source of sound improves the effectiveness of binaural sound in delivering data and/or realism to the listener.

- 25 The sound can also be convolved to originate from locations adjacent to or near the line-of-sight. With some sounds, a listener is not able to audibly distinguish between a sound originating exactly from the visible source of the sound (e.g., exactly along the line-of-sight to the image) and a sound originating from a location adjacent to the image or adjacent to the line-of-sight. Sound convolved to a coordinate location
- 30 sufficiently close to a visible source of the sound can cause the listener to localize the sound at the sound source. Success in altering a localization of a listener depends on

several factors, such as distance between the listener and the source of the sound, a loudness of the sound, a type of sound (e.g., whether the sound is familiar or unfamiliar, voice or non-voice), a size of the source of the sound, whether other noise or other sounds are present, and other factors. For example, sound is convolved to originate on the line-of-sight or within a predetermined distance from the line-of-sight.

Consider an example in which a display in an apartment store shows video advertisements. The display has no speakers. Instead, a sound localization system (SLS) wirelessly transmits binaural sound to listeners through electronic earbuds, earphones, or headphones that the listeners wear. As listeners walk near the display, they hear binaural sound originate from the display. In some instances as the listeners walk by, the SLS does not have exact coordinates to convolve sound to originate from a middle or center of the display (for example, the SLS does not have HRTF coordinates corresponding to a center position of the display for a known head orientation of a listener, or an accurate head orientation is unknown). In this situation, the SLS localizes the sound so it appears to originate next to the display, such as on an edge of the display or a few inches from the display. When the listener sees the display, the listener localizes the sound as originating from the location of the display since the audial cues of the binaural sound suggest to the listener a location next to or close to the display.

A volume of the sound can also be adjusted to assist a listener in localizing binaural sound to the sound source when the sound is convolved to a location other than the sound source. For example, an example embodiment convolves sound to have an adjusted volume level that corresponds to the distance from the listener to the visible source of the sound even when the distance to where the sound is convolved is different (such as a distance reaching beyond the visible source of the sound). Adjusting the volume level assists the listener in localizing the sound at the visible source of the sound and not at a different distance.

Consider an example in which a listener telephones a friend on a smartphone that displays a real-time video of the friend during the telephone call. The listener holds the smartphone about one foot away from his face while he talks to his friend and watches the video of his friend. An image of the friend on the display of the

5 smartphone is large and is proportioned to represent a size of the friend as if the friend were standing one foot from the face of the listener. Even though the smartphone is within a near-field distance from the face of the listener, the smartphone executes HRTFs with a far-field location and convolves the voice of the friend to a location that is four feet away from the face of the listener. The location is

10 behind the smartphone and along a line-of-sight from the listener to the smartphone. The smartphone further adjusts a volume of the voice of the friend to coincide with a distance of one foot in front of the face of the listener, not four feet from the face of the listener. The volume thus corresponds to a distance from the listener to the image of the friend and not a distance from the listener to the coordinates to where the

15 smartphone convolves the sound.

Figure 3 is a method that improves a user experience while listening to binaural sound that localizes to a sound source.

20 Block 300 states display, with an electronic device, two or more sound sources to a person.

The electronic device provides or presents the sound sources to the person, such as displaying images on, with, or through a display of the electronic device (see block

25 100 for further examples).

In an example embodiment, a display of the electronic device is divided, partitioned, or split into two or more portions or windows. Each portion includes an image of one of the sound sources.

30

Block 310 states improve the user experience of the person by processing sound of one or more of the sound sources with sound localization information (SLI) that positions the sound to a location that is behind the one or more sound sources and at an angle with respect to a line-of-sight from the person to the one or more sound sources so the person perceives an origin of the sound as originating from the location of the one or more sound sources.

Binaural sound includes audial cues to cause a listener to localize the sound to a location that is offset from the line-of-sight of the listener to the sound source. For example in spherical coordinates, the offset has an azimuth angle (θ) and/or an elevation angle (ϕ).

Consider an example in which a listener talks with an intelligent user agent (IUA), intelligent personal assistant (IPA), or other computer program on an electronic device with a display. The display simultaneously shows an image representing the IPA or data provided by the IPA and an image of the listener. The listener faces the display with a forward-looking direction between the two images. For instance in spherical coordinates, the listener is located at $(0, 0, 0)$, and a center of the display is located at $(0.3 \text{ m}, 0, 0)$. An image of the IPA is on a right side of the listener at $+\theta_1$, and an image of the listener is on a left side of the listener at $-\theta_2$ while the listener looks straight ahead with the forward-looking direction. An example embodiment positions or convolves a voice of the IPA to a position behind the electronic device at an angle with a positive azimuth coordinate. For instance, if the forward-looking direction has an azimuth coordinate of $\theta = 0^\circ$, then the voice of the IPA is convolved with coordinates within a range of $0^\circ < \theta < 30^\circ$ (such as $\theta = 5^\circ, 10^\circ, 15^\circ, 20^\circ, 25^\circ$, or 30°). Further, the voice of the IPA is convolved to coordinates that occur behind the display with a distance $(r) > 0.3 \text{ m}$. For instance, the voice of the IPA is convolved with HRTF pairs corresponding to spherical coordinates located in the following range: $r > 1.0 \text{ m}$, $0^\circ < \theta < 30^\circ$, and $\phi = 0^\circ$.

One problem in the technological field of binaural sound is that a listener may need to quickly change between listening to sound as binaural sound and listening to the sound as mono sound or stereo sound.

- 5 One or more example embodiments solve this problem and provide a quick and convenient way for a listener to change between listening to sound as binaural sound and listening to the sound as mono sound or stereo sound so as to discontinue externalization of the sound.
- 10 Figure 4 is a method that detects an action of a portable electronic device and changes sound in response to detection of the action.

Block 400 states detect an action of a portable electronic device.

- 15 The actions include, but are not limited to, one or more of rotating the portable electronic device, moving of the portable electronic device (e.g., shaking the portable electronic device or moving it through the air in a predetermined way), gripping or holding the portable electronic device (e.g., grabbing the portable electronic device with a hand), activity of a person (e.g., sensing when the person is walking or running
- 20 or sitting), releasing the portable electronic device (e.g., releasing the portable electronic device from a hand), covering a sensor of the portable electronic device (e.g., covering or darkening a lens of a camera), detecting a face of a person (e.g., detecting with facial recognition software the presence or proximity of a person), detecting absences of a face of a person (e.g., detecting with facial recognition
- 25 software an absence of a face of a person), detecting or sensing light, detecting or sensing darkness, detecting or sensing presence of a person (e.g., with a sensor), detecting or sensing an identity or biometric of a person (e.g., detecting a fingerprint or thumbprint of the person, identifying a person by iris image, retina scan, ear form, or another biometric), detecting a change in an electrical power source of a PED (e.g.,
- 30 changing between battery-supplied power and another source of power), detecting a change in audio output configuring of a PED (e.g., changing from between sound

being output from speaker and sound being output from headphones, detecting the an event of headphones being plugged-in or unplugged, coupled to the PED or decoupled, powered on or off), or another action discussed herein.

- 5 By way of example, one or more sensors in the portable electronic device detects when the action occurs. For instance, these sensors include, but are not limited to, a camera, a gyroscope, an accelerometer, a magnetometer, a compass, an optical or capacitive scanner, a display, a proximity sensor, a light sensor, a pedometer, a fingerprint sensor, or another sensor.

10

Block 410 states change, in response to detecting the action, sound being provided to a listener (1) from being binaural sound to being mono sound or stereo sound or (2) from being mono sound or stereo sound to being binaural sound.

- 15 The portable electronic device changes or switches sound being provided to the listener in response to detecting the action. Consider an example in which a three-axes accelerometer and/or gyroscope in the portable electronic device senses rotation of the portable electronic device. In response to detecting the rotation, the portable electronic device takes an action with regard to the sound. These actions
- 20 include changing or switching the sound (1) from being binaural sound to being mono sound or stereo sound or (2) from being mono sound or stereo sound to being binaural sound. Other actions include, but are not limited to, muting the sound, lowering the volume, raising the volume, stopping the sound, ending or terminating a telephone call, placing a telephone call on hold, joining another call, joining another
- 25 virtual auditory space, muting or pausing or changing a particular sound type or input source, or performing another action.

- In an example embodiment, changing from binaural sound to mono sound or stereo sound or changing from mono sound or stereo sound to binaural sound occurs when
- 30 the portable electronic device detects one or more of a predetermined amount or

degree of rotation, a predetermined speed of rotation, and/or rotation in a particular direction or about a particular axis.

5 Consider an example in which the portable electronic device includes an inertial motion unit (IMU) with an accelerometer, magnetometer, and gyroscope. The IMU senses or detects an amount and/or speed of rotation of the portable electronic device. When the amount of rotation and/or speed of rotation reaches a predetermined threshold, the portable electronic device executes one or more of the actions (e.g., changes the sound from binaural to mono or from mono to binaural).

10 For example, a listener holds a smartphone in his or her hand and rotates the smartphone by a threshold value of ninety degrees (90°) to change the sound from binaural sound to mono sound. When the listener rotates the phone back (e.g., -90°), the sound changes from mono sound back to binaural sound. Rotation of the
15 smartphone by the threshold value while in the hand of the listener thus provides a convenient way to change between listening to sound in binaural sound and listening to the sound in stereo or mono sound.

Example embodiments are not limited to the threshold value or amount of ninety
20 degrees (90°) since other threshold values or amounts can be designated to trigger a change between binaural sound and mono or stereo sound. By way of example, other threshold values include, but are not limited to, one or more of twenty-five degrees (25°), thirty degrees (30°), thirty-five degrees (35°), forty degrees (40°), forty-five degrees (45°), fifty degrees (50°), fifty-five degrees (55°), sixty degrees (60°),
25 sixty-five degrees (65°), seventy degrees (70°), seventy-five degrees (75°), eighty degrees (80°), eighty-five degrees (85°), ninety degrees (90°), ninety-five degrees (95°), etc.

Consider an example in which a camera in a HPED detects a left and/or right facial
30 profile of a first user during a telephone call or other communication with a second user. An example embodiment positions or repositions where the voice of the second

user localizes to the first user in response to detecting the right and/or left facial profile. For example, when the HPED detects a right profile of the listener, the detection triggers a change in the convolution of the voice to a location with an azimuth coordinate (θ) of greater than positive seventy degrees ($+70^\circ$) and less than positive one hundred degrees ($+100^\circ$), **such that $+70^\circ \leq \theta \leq +100^\circ$** with respect to a line-of-sight of the first user.

Consider an example in which the action of changing sound between binaural sound and mono or stereo sound occurs when the electronic device detects a change in orientation of the electronic device with respect to a face and/or head of the user. When the change reaches or exceeds a threshold value, then execute the change. The change in orientation can occur in one of three ways. First, the orientation of the head and/or body of the user changes with respect to the electronic device while the electronic device does not move. For instance, a user rotates his head or moves with respect to a stationary camera, facing sensor (e.g., front-facing sensor, rear-facing sensor), or other sensor. Second, the orientation of the electronic device changes with respect to the user while the user does not move. For instance, a user holds a smartphone in his or her hand while the camera captures an image of the face and executes facial recognition and distance determination. The user rotates the smartphone so the camera no longer captures the face of the user. Third, both the user and the electronic device move to change the orientation of the user with respect to the electronic device. For instance, the user holds the smartphone in his hand and simultaneously rotates his head and the hand holding the smartphone.

Consider an example in which the action of changing sound from binaural to mono/stereo or from mono/stereo to binaural is triggered when a PED detects rotation of a particular rotational or angular speed of the PED. For example, a listener holds a smartphone in his or her hand and rotates the smartphone slowly and no change is triggered. When the listener rotates the smartphone quickly, a change is triggered. The change is triggered when the rotation occurs within a predetermined time or crosses another threshold, such as a predetermined number of revolutions

per second or radians per second. By way of example, a change in the sound is triggered when a quarter rotation or ninety degrees of rotation occurs within a range of 0.1 seconds – 0.5 seconds.

- 5 Consider an example in which a listener holds a smartphone in front of his face while talking to a friend. The listener sees an image of his friend, and a camera in the smartphone captures an image of the listener that transmits to the friend during the telephone call. A processor (in the smartphone or in a cloud server) processes the voice of the friend in order to be localized as binaural sound at the location of the
- 10 smartphone in the hand of the listener. When the listener rotates the smartphone ninety degrees downward so the display faces the ground, the voice of the friend changes from being provided to the listener in binaural sound to being provided to the listener in mono sound. When the listener rotates the near edge of the smartphone ninety degrees upwardly so the display again faces the listener, the voice of the
- 15 friend changes from being provided to the listener in mono sound to being provided to the listener in binaural sound.

- Consider an example in which a listener holds a smartphone in front of his face while talking to a friend. The listener hears the voice of the friend as binaural sound that
- 20 localizes to an image on the display of the smartphone. To switch the voice from being provided in binaural sound that externally localizes to the smartphone to being provided in mono or stereo sound that localizes inside a head of the listener, the listener performs one of the actions discussed herein. As one example, the smartphone changes the sound when a camera in the smartphone ceases or fails to
- 25 detect a face of the listener. For instance, provide binaural sound only while the camera detects the face of the listener. Change to mono sound or stereo sound when the camera no longer detects the face of the listener. As another example, the smartphone changes the sound when the camera or another sensor detects darkness. For instance, provide binaural sound if the camera or sensor detects a
- 30 certain level of light. Change to mono sound or stereo sound when the camera or sensor detects an obstruction or a certain drop in the level of light (e.g., the listener

puts his or her hand over the sensor or camera; the listener places the smartphone on the table, covering the display or camera; the listener obstructs the display or sensor by placing the smartphone against his or her body, etc.).

- 5 Consider an example in which an electronic device captures an image of a person with a camera. The electronic device executes a software application to detect a face and perform facial recognition. During the period of time that the camera detects the face of the person, the electronic device provides sounds to the person as binaural sound. When the camera no longer detects the face of the person, then the electronic
10 device performs an action (such as changing the sound from binaural sound to mono sound or stereo sound, terminating external localization of the sound by the person).

Facial detection and/or facial recognition enables a person to change quickly back and forth between external localization of binaural sound and internal localization of
15 mono or stereo sound. For example, during a telephone call or while playing a software game, a listener holds a HPED (e.g., holds a smartphone in his or her hand) or wears a WED (e.g., wears an electronic watch). A camera in the HPED or WED monitors the face of the listener. When the listener desires to change to mono sound or stereo sound, the listener rotates the HPED or WED so the camera ceases to
20 capture or detect the face of the listener. When the listener desires to change back to externalizing the sound, the listener rotates the HPED or WED so that the camera captures or detects the face of the listener.

Instead of or in addition to rotating the HPED or WED, an example embodiment
25 allows the listener to change the sound between binaural and mono and/or stereo by moving his or her head. A camera in the HPED or WED monitors the face of the listener. The HPED or WED changes the sound when the HPED or WED detects a change in head orientation or a change in gaze of the listener (e.g., the listener looks away from the camera or display or rotates his or her head by a predetermined
30 amount). For instance, the electronic device changes from binaural sound to mono or stereo sound when one of the following occurs and/or changes from mono or stereo

sound to binaural sound when one of the following occurs: the listener stops gazing or looking at the display, the listener turns his or her head away from the display, the camera no longer detects the face of the listener, the camera detects a **“full face”** view, a side profile, a **“three-quarter”** view, or another view between a **“full face”** view and a profile of a face of the listener, the camera detects a top of the head of the listener, and the camera detects that the eyes of the listener are closed for a predetermined amount of time.

Consider an example in which two people (e.g., a first person and a second person) talk to each other during a telephone call. Their voices externally localize to each other as binaural sound to images on displays of their respective HPEDs. A camera or facing sensor in the HPED captures and/or detects a face of the person. Convolution is adjusted in response to sensing a change in orientation of a head of a person, such as a change in a profile angle of a face of a person. For example, when the face of the first person is oriented toward the display, then convolve the voice of the second person as binaural sound to the location of or behind the display. When the face of the first person moves to a position exposing a right facial profile to a display of the HPED, the voice of the second person moves. For instance, the HPED moves the voice of the second person from convolving the voice to an azimuth direction (θ) of zero degrees (0°) to convolving the voice to an azimuth direction of positive ninety degrees ($+90^\circ$) with respect to a facing direction of the head of the first person. When the orientation of the head of the first person relative to a display of the HPED changes to a second relative orientation such that a left facial profile faces a display of the HPED, the voice of the second person moves. For instance, the HPED adjusts the convolution of the voice of the second person such that the first person localizes the voice at a location with an azimuth coordinate (θ) of negative ninety degrees (-90°) with respect to the facing direction of the head of the first person. As the electronic device captures and detects a change in the facial orientation, the example embodiment adjusts the convolution of the voice of the second person so that the first person continues to localize the voice at the electronic device.

An example embodiment improves the user experience of a listener by enabling the listener to find an electronic device, or identify which of multiple electronic devices is the sound source of binaural sound that the listener is hearing and localizing.

Consider the example above in which the displays are turned off during a phone call so that images are not displayed at the HPEDs. During the phone call, the electronic devices function as the sound sources rather than the images displayed on or with the electronic devices. The example embodiment determines the orientation of the head of the listener and convolves the sound (here, a voice) to a position on a line extending from the center of the head of the person to and through the HPED of the person. When the orientation of the HPED changes relative to the head of the person receiving the sound, the voice is convolved to a position on a new line extending from the head of the person to and through the HPED of the person.

Consider an example where an electronic device monitors the orientation of a head of a listener, and the measurement of the orientation of the head is communicated to or available to other electronic devices that do not monitor head orientation directly.

Consider an example in which a listener wears wireless earphones while walking in a department store. When the listener gazes at a display, a camera detects the face and gaze of the listener. In response to detecting the face, the display plays a content-specific advertisement to the listener. Binaural sound from the advertisement is convolved such that the listener will externally localize the sound at the display. When the listener turns his or her head, the camera detects a change in the orientation of the head of the listener and that the forward looking direction of the listener no longer intersects the display and stops playing the binaural sound to the listener.

Sound can also change between binaural sound and mono or stereo sound when the electronic device detects darkness, detects light, or detects blockage of a sensor. For example, in response to detecting when a lens of a camera is blocked, cease providing sound to a person in binaural sound and commence providing the sound to the person in mono or stereo sound.

Consider an example in which a listener talks to another person during a telephone call while holding a smartphone or other HPED. The listener hears the voice of the other person as binaural sound that localizes at or on the other side of the HPED.

- 5 The HPED changes to mono or stereo sound upon detecting an action from the user, such as detecting blockage of the camera (e.g., a finger on the lens of the camera), detecting a fingerprint or thumbprint, detecting a finger or thumb on the display, detecting a facial gesture or hand gesture, or detecting another action. Detection of one of these actions enables the listener to change quickly between binaural sound
10 and mono or stereo sound.

- Changing between binaural sound and mono or stereo sound can also occur in response to detecting or sensing a change in distance of a listener from an object, such as the electronic device. For example, a camera or facing sensor in a HPED
15 tracks an image or orientation of a person or face of a person during a telephone call. The person hears the voice of the other person during the telephone call in binaural sound. The HPED automatically switches or changes the voice from externally localizing in binaural sound to localizing in one of mono or stereo sound when the person moves a predetermined distance from the HPED. For instance, change the
20 sound when the person moves more than one meter away from a present position or from the HPED, more than 1.5 meters away, more than 2.0 meters away, etc. A camera or sensor captures an image or orientation of the head of the person, and the distance of the person or head from the HPED is determined based on a size of the face and/or body image captured or sensed with the camera or sensor.

- 25 Consider an example embodiment that monitors states of a PED providing sound to a listener and changes the sound in response to change in a state. For example, a listener without headphones hears sound from a single speaker included in the body of a PED. The listener couples or plugs-in headphones to the PED for private
30 listening. Alternatively, the listener commences to listen with wireless headphones that communicate with the PED. The example embodiment detects the change in the

audio output device from the speaker to the headphones. The detection of the change of output device triggers the example embodiment to begin convolution of the sound, now being output to the headphones. One or more processors (such as a processor in the PED or in communication with the PED) convolves the sound so it

5 externally localizes to the listener as originating at the speaker at the PED. As such, the listener hears the sound as originating from the speaker of the PED even though the speaker is not actually generating the sound anymore. The listener experiences little or no change in localization of the sound between hearing the sound from the speaker and through the air, to hearing the sound through headphones and

10 convolved to a position at the PED or behind the sound source or PED.

Consider further this example in which the listener wears headphones and hears binaural sound that originates from the PED. After some time, the voltage level of the PED drops below a predetermined threshold and a power state of the PED changes

15 to **"low battery."** The change in state triggers the example embodiment to discontinue convolution of the sound to binaural sound and instead to continue to play the sound output to the headphones in mono sound. Ceasing to execute processes and/or hardware that convolve the sound preserves battery power. This process conservation also improves the performance of the PED by prolonging the duration of

20 the powered-on state of the PED. Further, changing of the sound from binaural sound that externally localizes to the listener to mono sound also improves the experience of the listener by serving as an alert to the listener of the **"low battery"** state of the PED.

25 Figures 5 – 8 show example embodiments with various electronic devices, such as a TV or display, HPED, WED, HMD, OHMD, wireless earphones or headphones. Example embodiments, however, are applied with other types of electronic devices as well.

30 Figures 5A – 5H show a listener 500 interacting with a handheld portable electronic device (HPED) 510 to change sound between being provided in binaural sound and

being provided in mono or stereo sound. The listener hears the sound through an electronic device 520, such as headphones, earphones, earbuds, or OHMD. Each figure includes a sound localization point (SLP) 530A – 530H shown as an enlarged asterisk (*) that illustrates from where the listener hears the sound as originating. For illustration, the listener 500 is using the HPED 510 to communicate with a user (e.g., talking with a person, an IPA, an IUA, a bot, or a computer program). For example, the communication occurs during a telephone call or voice exchange with the user. The SLP thus represents an origin of the voice of the user to the listener (e.g., a spot where the voice of the user is heard by the listener to originate).

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In figure 5A, the listener 500 hears the voice of the user in mono or stereo sound through the electronic device 520, and the SLP 530A is located inside a head of the listener 500. For example, the listener 500 receives or initiates a telephone call with the user through the HPED 510, and the listener hears the voice of the user in a conventional way as mono or stereo sound through the electronic device 520.

In figure 5B, the listener 500 hears the voice of the user in binaural sound through the electronic device 520, and the SLP 530B is externally located outside the head of the listener 500. The HPED 510 displays an image 540 of the user, and the image 540 is the sound source to the listener. The listener 500 perceives or believes the voice of the user originates from the image 540 that is being displayed on the display of the HPED. The HPED, however, is not emanating sound through its speakers since the voice of the user is being provided to the listener 500 through the electronic device 520 worn on the head of the listener.

25

In figure 5B, a processor (such as a processor in the HPED 510) convolves the voice of the user to a coordinate location 550 that is behind the HPED 510. For illustration, the coordinate location 550 is shown as an image of a head of the user. The coordinate location 550 is located on a line-of-sight 560 that extends from the head or face of the listener 500, through the image 540 on the display of the HPED, and to the coordinate location 550.

30

When the listener 500 holds the HPED 510 in his or her hand and in front of his or her face (figure 5B), a distance from the head of the listener 500 to the HPED 510 is a near-field distance (d_1). The coordinate location 550, however, is located a
5 distance (d_2) away from the HPED 510 in order to be at a far-field distance from the listener 500. As such, the distance of the coordinate location 550 from the head of the listener 500 is greater than or equal to one meter: $d_1 + d_2 \geq 1.0 \text{ m}$.

Consider an example in which the HPED 510 is a smartphone, and the listener 500 in
10 figure 5B holds the smartphone one foot in front of his face (e.g., $d_1 = 1.0 \text{ ft}$). The smartphone has a spherical coordinate location of $(1.0 \text{ ft}, 0^\circ, 0^\circ)$ with respect to the head of the listener 500 at the origin. In order for the listener to localize a voice of the user to the smartphone, near-field HRTFs could be selected to have coordinates that match the spherical coordinate location of the smartphone (e.g., select an HRTF pair
15 corresponding to a coordinate location of $(1.0 \text{ ft}, 0^\circ, 0^\circ)$). As explained herein, convolving sound with such near-field HRTFs can be problematic. Instead of using these near-field HRTFs, an example embodiment instead selects far-field HRTF pairs. For example, the smartphone selects far-field HRTFs that have a spherical coordinate location of $(3.2 \text{ ft}, 0^\circ, 0^\circ)$. The voice of the user is convolved to a location
20 that is behind the smartphone (e.g., convolved to coordinate location 550). The listener 500 will hear the voice of the user as if originating from the location of the smartphone since the coordinate location 550 is aligned with the image 540.

In the example of the HPED being a smartphone, the listener may perceive a
25 discrepancy between the location of the image 540 and the location of the coordinate location 550. For instance, the listener localizes the voice of the user to the coordinate location 550 but sees the image 540 of the user at a closer location where the smartphone is located. The discrepancy is relatively minor, and further minimized for small values of d_2 . One way to minimize or eliminate the discrepancy is to place
30 the coordinate location 550 on the line-of-sight 560. Convolving the voice along the line-of-sight reduces or eliminates a discrepancy in localization between the percept

of the image 540 at a distance of d_1 and a binaural sound convolved to a different coordinate location 550.

Figures 5C and 5D show examples of how the listener 500 easily and quickly
5 switches between hearing the sound as binaural sound and hearing the sound as mono or stereo sound.

In figure 5C, the listener 500 flicks or rotates the HPED 510 from a first position (shown in dashed lines with a display facing toward the face and/or head of the
10 listener) to a second position (shown in solid lines with a display facing the ground or away from the face and/or head of the listener). The rotation is shown with arrow 560. After the HPED 510 rotates per arrow 560, the sound localizes to the listener as mono or stereo sound inside his or her head at the SLP 530C. When the HPED detects or senses the rotation, sound changes from being provided as binaural sound
15 to being provided as mono or stereo sound.

In figure 5D, the listener 500 flicks or rotates the HPED 510 from a first position (shown in dashed lines as facing the ground or away from the face and/or head of the
20 listener) to a second position (shown in solid lines as facing the face and/or head of the listener). The rotation is shown with arrow 570. After the HPED 510 rotates per arrow 570, the listener localizes the sound as binaural sound outside his or her head at the SLP 530D. When the HPED detects or senses the rotation, sound changes from being provided as mono or stereo sound to being provided as binaural sound.

25 Figures 5E – 5G show more examples how the listener 500 easily and quickly switches between hearing the sound as binaural sound and hearing the sound as mono or stereo sound.

In figure 5E, the facing sensor or camera 580 captures an image of the face of the
30 listener 500. The listener continues to localize the binaural sound externally to the HPED at SLP 530E as long as the face of the listener 500 remains in a field-of-view

(FOV) 582 of the camera. Figure 5E shows the listener rotating the HPED 510 by an azimuth angle (θ). As the listener rotates the HPED within the FOV 582, he or she continues to localize the sound to the SLP 530E while the sound continues to be convolved to the coordinate location 550 that is behind the HPED.

5

Figure 5F shows the listener 500 rotating the HPED 510 so the face of the listener is outside the FOV 582 of the facing sensor or camera 580. The movement causes the sound to change from being provided to the listener as binaural sound to being provided to the listener as mono or stereo sound. When the HPED detects or senses that the face of the listener is no longer in the FOV of the camera, sound changes from being provided as binaural sound to being provided as mono or stereo sound. The listener now localizes the sound as mono or stereo sound to the SLP 530F located inside the head of the listener.

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In figure 5G, the sound switches between binaural sound and mono or stereo sound when the HPED is placed onto or removed from an object 590 (such as a table or other surface). For example, when the HPED 510 is placed on the object 590, the display, camera, or other sensor is covered, obstructed, or darkened. Sensing the placement or the action of the placement triggers the processor to change how the sound is convolved and/or how the sound is provided to the listener. For instance, in response to sensing the HPED being placed on the object 590, change the sound from being provided to the listener as binaural sound to being provided as mono or stereo sound. The listener now localizes the mono or stereo sound to the SLP 530G located inside the head of the listener. When the listener retrieves or removes the HPED from the object 590, the sound changes from being provided as mono or stereo sound to being provided as binaural sound that externally localizes to the listener.

20

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Figure 5H shows that the coordinate location 550 remains behind the HPED 510 and on the line-of-sight 560 as the listener 500 moves the HPED while communicating with the user. For example, the listener moves the HPED from the position shown in

30

figure 5B to the position shown in figure 5H. The origination point of the voice of the user thus tracks the position of the HPED as the listener holds the HPED in his or her hand and moves the HPED to different locations. The listener hears the voice of the user as binaural sound at or near 530H as if the voice were originating from or
5 emanating from the location of the HPED when in fact the listener hears the voice of the user through the electronic device 520.

As the listener moves the HPED during the communication with respect to his or her face or head orientation, the sound localization information (SLI) processing the voice
10 of the user changes. For example, the processor convolves or processes the voice of the user with new or different sets of HRTFs in order to change the coordinate location 550 so that it remains behind the HPED relative to the user during the communication.

15 SLPs 530B, 530E, and 530H appear at, slightly behind, and slightly in front of the sound source at the HPED 510. This illustrates that a listener may not localize a SLP to an exact coordinate location. A listener associates the sound convolved to location 550 with the visible HPED 510 and the association results in the listener localizing the convolved sound at the area occupied by the sound source. The SLP may not have
20 a precise coordinate location, the SLP can vary depending on the circumstances such as the type of sound, the auditory environment, the sensitivity of the listener, the visibility of the sound source, a distance from the listener to the sound source, and other factors.

25 An example embodiment determines a gaze direction or looking direction of the listener independent of the orientation of the head of the listener. For example, a gaze tracker or detector, facing sensor or other sensor monitors the gaze angle of the listener, or a camera captures an image of the face of the listener and the image is analyzed to determine the direction that the listener is looking. The example
30 embodiment selects HRTF pairs for coordinates that intersect or coincide with a line extending from the head of the listener in the direction of the gaze or the looking

direction. The listener hears the sound convolved such that the sound appears to originate from the direction that the listener is looking.

5 Consider an example where the sound is convolved to a point on the other side of a sound source (such as a HPED and/or other objects) and does not localize to the listener unless the gaze angle of the listener intersects with the sound source. The listener hears the sound externally localized when the listener looks at the sound source, such as the HPED or other object. When the gaze angle is not directed to the sound source then the sound of the sound source is paused, muted, or played
10 without being externally localized (e.g., the sound is provided to the listener as mono sound or stereo sound).

Consider a similar example in which the listener hears localizations of binaural sounds at or beyond one or more sound sources while the gaze of the listener is not
15 toward the sound source. When the gaze is detected as being toward a sound source, the sound of the sound source is switched to mono sound or stereo sound, paused, muted, or adjusted in another way. This allows the listener to focus on a particular sound source by looking at the sound source. While looking at the sound source, the sound source localizes in his or her head, while other sound sources continue to
20 externalize out and away from the listener.

Consider an example in which the listener holds the HPED in front of his or her face during the communication at spherical coordinate location (r, θ, ϕ) of $(0.3 \text{ m}, 0^\circ, 0^\circ)$. A processor processes the voice with HRTFs corresponding to coordinates $(1.0 \text{ m}, 0^\circ, 0^\circ)$ so the voice of the user localizes for the listener on the far side of the HPED from the listener. The listener then rotates his or her head on the vertical or longitudinal axis by negative twenty degrees $(\theta = -20^\circ)$. In response to the change in head orientation, the processor convolving the voice of the user retrieves a new HRTF pair corresponding to coordinates $(1.0 \text{ m}, +20^\circ, 0^\circ)$ and processes the voice of the user
25 with the new HRTF pair. The voice of the user continues to localize to the listener as if from the HPED.
30

Consider an example in which a person holds a HPED in his or her hand and is on a telephone call with another user. The HPED includes a camera that captures an image of the person and also includes a display that displays an image of the user as the sound source. A facial recognition and/or head tracking system monitor a head orientation of the person during the telephone call. When the person changes his or her head orientation by or beyond a predetermined amount or threshold amount, the voice of the user that the person hears changes from binaural sound to mono sound or from mono to binaural. For example, the HPED changes the voice of the user from binaural sound to sound that the person localizes inside his or her head in response to the HPED detecting a predetermined change in the head orientation. For example, the change of the orientation of the head is relative to the HPED such as an azimuth angle change due to head rotation on a vertical axis of the head and/or a change in the pitch angle of the head resulting from head rotation on the frontal axis of the head. For instance, the predetermined amount or threshold includes rotation in one or more axes by one or more of twenty-five degrees (25°), thirty degrees (30°), thirty-five degrees (35°), forty degrees (40°), forty-five degrees (45°), fifty degrees (50°), fifty-five degrees (55°), sixty degrees (60°), sixty-five degrees (65°), seventy degrees (70°), seventy-five degrees (75°), eighty degrees (80°), eighty-five degrees (85°), or ninety degrees (90°). These predetermined amounts or thresholds are applied to other example embodiments as well.

Figures 6A and 6B show an electronic or computer system 600 in which a listener 610 hears voices from three different users whose voices localize externally to the listener 610 as binaural sound to three different images 620A, 620B, and 620C on a display 630 of an electronic device 640. The listener wears an electronic device 612 (e.g., wireless earphones, wireless headphones, a HMD, or OHMD) that wirelessly communicate with the electronic device 640 to hear the voices as binaural sound. By way of example, the three different users are people engaged in a telephone call with the listener 610, images displayed during an advertisement, or computer programs (e.g., an IPA, IUA, bot, characters in a computer game, independent processes or

tasks, windows, etc.). The electronic device 640 is shown as a flat display but includes different types of displays and electronic devices, such as a television (TV), a curved display, an edge display, a 3D TV, a projector and projection, a virtual display, etc.

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The electronic device 640 includes a sensor 650 that determines one or more of a presence or existence of a person or avatar, a distance to a person or avatar, a gaze or looking direction of a person or avatar, a voice of a person or avatar, a facing direction of a person or avatar, and gestures of a person or avatar. For example, the
10 sensor 650 is a motion sensor, presence sensor, camera, proximity sensor, infrared sensor, facing sensor, a virtual sensor, a position of a VR camera or virtual point-of-view (POV), etc.

The listener 610 sees each image 620A, 620B, and 620C along a respective line-of-
15 sight 660A, 660B, and 660C while the listener stands a near-field distance (d) from the display 630. The listener, however, perceives the images at different distances with respect to the listener. Images 620A and 620B appear to be located at the surface of the display 630. Image 620C, however, appears to be located farther away than a wall or virtual wall 622 at which the display 630 is located. For example, the
20 perception of the greater distance to image 620C is created by the display 630 being a display that provides for the viewer a perception of distance or 3D space (e.g., a 3D TV or display, a HMD, a display showing stereoscopic video or images). A distance (d_1) from the listener 610 to the location of the image 620A is a near-field distance. A distance (d_2) from the listener 610 to the location of the image 620B is a near-field
25 distance. A distance (d_3) from the listener 610 to the location of the image 620C is a far-field distance.

Since distances d_1 and d_2 are near-field distances, voices of the users corresponding to images 620A and 620B are convolved with HRTFs having
30 coordinate locations 670A and 670B that are far-field distances. Since distance d_3 is a far-field distance, the voice of the user corresponding to image 620C is convolved

with a HRTF pair having a distance coordinate that matches or corresponds to the far-field distance of d_3 . The listener perceives a voice at image 620A at its location on the display 630 even though the voice is convolved with HRTFs of coordinate location 670A. The listener perceives a voice at image 620B at its location on the display 630 even though the voice is convolved with HRTFs of coordinate location 670B. The listener perceives a voice at image 620C at its location behind or beyond the display 630 where the listener visually localizes the image 620C and where the sound is convolved to originate. Coordinate locations 670A and 670B are behind wall 622.

Figure 7 shows an electronic or computer system 700 in which two listeners 710 and 720 are engaged in a telephone call in accordance with an example embodiment.

Listener 710 sits in a chair 711 with a laptop computer 722 resting on a table 724 while the listener 710 talks to listener 720. An image 730 of the listener 720 appears on the display of the laptop computer 722. The listener 710 hears a voice of the listener 720 through headphones or earphones 732 that wirelessly communicate with the laptop computer 722.

A voice of the listener 720 localizes to the listener 710 as binaural sound that is heard to emanate from or originate from the image 730 on the display of the laptop computer 722. A processor (e.g., a processor in the laptop computer 722 or elsewhere in the computer system 700) processes the voice of the listener 720 with HRTFs for coordinate location 736 that is behind the laptop computer 722.

The coordinate location 736 is on a line-of-sight 738 that extends from a head of the listener 710 to the image 730 displayed on the laptop computer 722. The coordinate location 736 is shown in empty space behind the laptop computer 722. A distance (d_1) from the head of the listener 710 to the image 730 is a near-field distance that is less than one meter. A distance ($d_1 + d_2$) from the head of the listener 710 to the coordinate location 736 is a far-field distance that is one meter or more. As such, the processor processes or convolves the voice of the listener 720 with far-field HRTFs

even though the image 730 where the listener perceives the origination of the voice is located at a near-field distance with respect to the listener 710.

Listener 720 talks to listener 710 while listener 720 sits in a chair 721 with a
5 smartphone 752 in a hand of the listener in front of his or her face. An image 760 of
the listener 710 appears on the display of the smartphone 752. The listener 720
hears a voice of the listener 710 through headphones or earphones 754 that
wirelessly communicate with the smartphone 752. The smartphone 752 wirelessly
communicates with the laptop computer 722 over one or more networks 760 while
10 the listeners 710 and 720 are remote from each other at different geographical
locations.

A voice of the listener 710 localizes to the listener 720 as binaural sound perceived
by listener 720 as emanating from or originating from the image 760 on the display of
15 the smartphone 752. A processor (e.g., a processor in the smartphone 752 or
elsewhere in the computer system 700) processes the voice of the listener 710 with
HRTFs having a coordinate location 766 that is behind the smartphone 752. The
coordinate location 766 is located on a floor 770 located next to a stack of books 772
in a room where the listener 720 is located.

20 The coordinate location 766 is on a line-of-sight 768 that extends from the listener
720 to the image 760 displayed on the smartphone 752. A distance (d_3) from a head
of the listener 720 to the image 760 is a near-field distance that is less than one
meter. A distance ($d_3 + d_4$) from the head of the listener 720 to the coordinate
25 location 766 is a far-field distance that is one meter or greater. As such, the
processor processes or convolves the voice of the listener 710 with far-field HRTFs
even though the image 760 where the voice is perceived is located at a near-field
distance with respect to the listener 720.

30 Figures 8A and 8B show an electronic or computer system 800 in which a listener
810 sits at a table 820 and engages in a telephone call or other type of

communication with two users via a portable electronic device 840. Images 830A and 830B of the two users appear on a display 850 of the portable electronic device 840 while the listener 810 talks to the users. The images 830A and 830B of the two users move and interact with the listener 810 in real-time. For example, the images are
5 software programs or people with whom the listener 810 talks. For instance, the users are people and the images 830A and 830B are real-time video of the users during a conference call. As another example, one user is a person and one user is a bot; the images of both users are avatars; and the avatars are visually perceived by listener 810 as two-dimensional or three-dimensional AR images in a 3D environment
10 of the listener (e.g., using stereoscopic video, holograms, light fields, or another type of display or projection).

The display 850 is divided into two halves or two sections 855A and 855B. Section 855A displays image 830A, and section 855B displays image 830B. This situation
15 occurs, for example, when the listener 810 talks with two different users. Example embodiments include a listener engaging in visual telephony with a different number of other users, such as a single user, three users, ten users, twenty users, or another number of users. Each user may be presented as an image and/or a section or area of a display or other location (including AR and VR images).

20 A camera 860 in the portable electronic device 840 captures an image of the listener 810 and provides the image and/or video to one or more of the users. Further, the camera 860 and one or more software programs perform other functions, such as detect and recognize a face of the listener 810, determine or monitor a presence of
25 the listener 810, determine a distance of the face of the listener from the display 850, determine an angle of the face of the listener or an orientation of the head of the listener 810 relative to the camera 860 and/or relative to the display 850 of the electronic device 840, and perform other functions discussed herein.

30 The listener 810 is located a near-field distance from the display 850 of the electronic device 840. HRTFs having near-field distance coordinates may not be available or

desirable for convolution of the voices of the users for the listener in a near-field range. Instead, an example embodiment convolves the voices with HRTFs having far-field distance coordinates. The coordinate locations of these HRTFs fall beyond or behind the display 850 of the electronic device 840.

5

A processor processes or convolves the voice of each user with a different pair of HRTFs so the voices are not heard to overlap or localize from a coincident or matching location during the communication. For example, the processor convolves the voice corresponding to image 830A with HRTFs having a coordinate location at 10 870A and convolves the voice of image 830B with HRTFs having a coordinate location at 870B. These locations are separated from each other on opposite sides of azimuth angle A3 having a vertex at the head of the listener. Coordinate locations 870A and 870B are shown to exist in empty space behind the display 850 of the electronic device 840 with respect to the location of the head of the listener 810.

15

The listener 810 hears a voice from image 830A as binaural sound that originates from a location 875A. The location 875A corresponds to or matches the location of the image 830A on the display 850 relative to the orientation of the head of the listener. The listener 810 hears a voice at image 830B as binaural sound originating 20 from location 875B. Location 875B corresponds to or matches the position of the image 830B on the display 850 as heard by the listener 810.

25

The listener 810 has a forward-looking direction off to the side of the display 850 with a line-of-sight 880 along $\theta = 0^\circ$. The voice of a user is convolved with HRTFs included within a range of coordinate locations that provide for the binaural sound to be rendered behind the respective image of the user (here image 830A or 830B) and behind the display 850 relative to the head of the listener 810.

30

Rays R1 – R4 extending from the head of the listener 810 and angles A1 – A3 having vertices at the head of the listener 810 are shown to illustrate example ranges for azimuth coordinates of HRTF pairs. The voice or other sound of a user is convolved

with an HRTF pair having an azimuth coordinate within the range of the angle occupied by the image or display section corresponding to the user. Convolver the voice with an HRTF pair within the azimuth range allows the listener 810 to externally localize the voice or other sound of a user such that the listener experiences the binaural sound as originating at the image of the user. Ray R1 has an azimuth coordinate of θ_1 . Ray R2 has an azimuth coordinate of θ_2 . Ray R3 has an azimuth coordinate of θ_3 . Ray R4 has an azimuth coordinate of θ_4 . Angle A1 has sides R3 and R4. Angle A2 has sides R1 and R2. Angle A3 has sides R1 and R4. As such the size of angle A1 is the difference of θ_4 and θ_3 , the size of angle A2 is the difference of θ_2 and θ_1 , and the size of angle A3 is the difference of θ_4 and θ_1 .

To localize the sound corresponding to image 830A, an example embodiment selects HRTF pairs having azimuth angle coordinates between θ_3 and θ_4 . Here, θ_4 is greater than θ_3 and less than or equal to the azimuth coordinate of location 870A. The azimuth angle of ray R4 and of coordinate location 870A represents the alignment of a right-side edge or boundary of image 830A from the POV of the head of the listener 810 that has a forward-facing orientation of $\theta = 0^\circ$. The azimuth angle of ray R3 represents the alignment of a left-side edge or boundary of image 830A with respect to the head of the listener. The listener 810 observes the image 830A within the angle A1. The listener 810 hears the sound of the voice of a user originating from within the angle A1 and from the image 830A when the voice is convolved with a HRTF pair having an azimuth coordinate θ such that $\theta_3 \leq \theta \leq \theta_4$. For example, location 870A has an azimuth coordinate equal to θ_4 and so the voice of the user shown as 830A is convolved with a HRTF pair corresponding to location 870A, and localizes to the listener at image 830A (e.g., 875A).

Sound is convolved behind image 830B by HRTFs with an azimuth angle in the range between θ_1 and θ_2 or interior to the angle A2. Ray R1 represents an edge or boundary for where the image 830B is seen by the listener from the head orientation of forward facing ray 880. An opposite edge or boundary of the image 830B as seen

by the listener with the head oriented toward $\theta = 0^\circ$ is represented by ray R2. The azimuth angle of coordinate location 870B is a value between or included by the azimuth angle coordinate of ray R1 and ray R2. As such, the listener 810 perceives sound convolved to location 870B as emanating from the image 830B such as from point 875B.

The images 830A and 830B of the users appear close beside each other on the display 850. The voices of the users, however, are convolved to distant points 870A and 870B on opposite sides of angle A3 that are farther apart than the images of the users. This improves the user experience by preventing the listener from localizing the two voices as overlapping and assists the listener in spatially distinguishing the two sound sources from each other.

For ease of illustration azimuth angles of Figure 8A are shown and discussed herein. Example embodiments also similarly calculate elevation coordinates in order to select HRTF pairs that are aligned with the image or sound source from the point of view of the head of the listener. The example embodiments select elevation angles from those that fall between a ray that bounds a lower edge of an image, area of a display, or sound source and a ray that bounds an upper edge of an image, area of display, or sound source (the rays having endpoints at the head of the listener).

Providing HRTFs with a range of different azimuth (and/or elevation) angles solves a technical problem and assists in convolving the voices of the users. For example, HRTFs corresponding to coordinate location 870A may not be available. In this situation, other HRTFs are selected that correspond to coordinate locations with an azimuth angle interior of angle A1 (i.e., behind the display). Likewise, HRTFs having coordinate locations corresponding to the location of 870B may not be available. In this situation, HRTFs with other coordinate locations could be selected as long as the selected coordinate locations are aligned with the image 830B (e.g., with an azimuth angle within angle A2). Thus the objective of assisting the listener to localize a voice

of a user at the image or sound source representing the user can be achieved with multiple different HRTF pairs.

5 In figure 8B, the listener 810 has changed the position of the portable electronic device (PED) 840 to be directly in front of the listener. The HRTF pairs convolving the sound of the users have been updated to compensate for the change in the distance to and orientation of the head of the listener 810 relative to the images of the users displayed on the display 850. For example, the changes in the relative position of the head are determined by analyzing the facial profile angle from one or more images or
10 video captured by the camera 860, or by resolving head movement reported by a head tracking system with the movement of the PED 840 as reported by sensors of the PED. The user being represented by image 830B terminates or ceases the communication with the listener 810. The image 830B is replaced with an image 890 of the listener 810. The camera 860 captures an image of the listener 810, and the
15 electronic device 840 displays the image 890 on the display 850. During the communication, the listener 810 simultaneously sees a real-time image 890 of himself or herself and a real-time image 830A of the other user.

Figure 9 is a method that selects HRTFs based on a distance of a listener from a
20 sound source in accordance with an example embodiment.

Block 900 states determine a distance from a listener to a sound source.

25 One or more electronic devices or sensors of an electronic device determine a distance from the listener to the sound source. By way of example, the sensors include one or more of a camera, a proximity sensor, ultrasonic sensor, a radio frequency identification (RFID) tag and reader, laser, light source sensor, or other sensor that assists in determining a distance of an object from an electronic device.

30 The distance can represent the distance from the listener to an electronic device (e.g., an electronic device representing the sound source), to a display (e.g., a flat or

curved display displaying the sound source), to an AR image rendering to a listener as though in the physical environment, to a VR image in a virtual environment, or to another sound source.

- 5 As an example, a camera at the location of the sound source captures an image of a face of a listener and executes an algorithm to determine a distance of the face from the camera. For example, triangle similarity can be used to determine distance from the camera to a known object (e.g., a face) based on a size of the head and/or face of the captured image. For instance, a distance (D) to the face is a function of a
- 10 known width of the face (WF) times the focal length (FL) of the camera divided by the width of the pixels (WP). As another example, a facial recognition can be used to determine distance from the camera to the known object (e.g., a face) based on distances between one or more facial landmarks (e.g., eyes, nose, mouth, etc.).
- 15 As another example, a camera that is in communication with the electronic system captures an image that includes both the listener and the sound source that are away from the camera. The electronic system then uses the image to determine the life-scale distance between the listener and sound source included in the image. For example, image recognition software determines an angle and distance from the
- 20 camera to the listener (side A of a triangle) and an angle and distance from the camera to the sound source (side B of the triangle). An algorithm executing in the electronic system sums the two angles to determine the vertex angle at the camera between the listener and the sound source (i.e., between side A and side B). The algorithm then uses the law of cosines to calculate the distance between the listener
- 25 and the sound source (i.e., side C of the triangle).

- As another example, the listener wears a HPED (e.g., a smartphone) or wearable electronic device (e.g., a HMD) that displays an AR or VR image of the sound source rendered to be perceived at a particular distance with respect to an origin, such as a
- 30 location of the wearer. A distance from the listener to the sound source is based on a relative size of the image being displayed or a location or virtual location to where the

image is being rendered. For instance, the image is displayed at a real or virtual chair that is observed as two feet away from the wearer of the electronic device.

5 As another example, the listener wears electronic earphones or headphones that communicate with the HPED or other electronic device that displays the sound source. Communication between these two electronic devices establishes a distance from the listener wearing the electronic earphones or headphones and a sound source at the HPED or other electronic device.

10 As another example, software and/or hardware that positions, displays, and/or monitors locations of virtual objects in VR or AR is queried for and/or reports the distance between a head or virtual head of the listener and a sound source.

15 Block 910 makes a determination as to whether the distance is a near-field distance. A near-field distance is a distance less than one meter. A far-field distance is a distance greater than or equal to one meter.

20 If the answer to the determination is "no" then flow proceeds to block 920 that states process and/or convolve the sound with HRTFs having far-field coordinates that correspond to or match with the coordinate location of the sound source. For example, the determined distance from the listener to the sound source matches or equals a distance from the listener to the coordinate location corresponding to the HRTF pair being executed to convolve the sound.

25 A processor (such as a digital signal processor or DSP) processes the sound with SLI (including a pair of HRTFs). The HRTFs have a coordinate location that matches, approximates, or corresponds to a location of the sound source.

If the answer to the determination is “yes” then flow proceeds to block 930 that states process and/or convolve the sound with HRTFs having far-field coordinates so the sound localizes to the listener at the sound source.

- 5 A processor (such as a digital signal processor or DSP) processes the sound with SLI (including a pair of HRTFs). The HRTFs have a coordinate location that does not match, approximate, or correspond to a location of the sound source. For example, the HRTFs have a coordinate location that is away from or farther than the location of the sound source. For instance, the HRTFs have spherical coordinates with a
- 10 distance (r) coordinate that is larger than or greater than the distance from the listener to the sound source.

- An example embodiment executes one or more of the following so the sound localizes to the listener at the sound source when the HRTFs have a coordinate
- 15 location that does not match the location of the sound source: convolve the sound to a location on, near, along, or about the line-of-sight from the listener to the sound source, convolve the sound to a location that is behind or beyond the sound source, convolve the sound to a location that is behind or beyond the electronic device providing or displaying the sound source (e.g., an image of the sound source), and
- 20 convolve the sound to have a volume or loudness commensurate with the distance from the listener to the sound source (as opposed to the distance from the listener to the coordinate location of the HRTFs).

- By way of example, the sound localization information (SLI) are retrieved, obtained,
- 25 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, the information includes one or more of HRTFs, ILDs, ITDs, and/or other information discussed herein. Instead of being retrieved from
- 30 memory, 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 a desired SLP or the sound source. For example, if the SLP is to be 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 the location. For instance, the retrieved HRTFs have a coordinate location that matches or approximates the coordinate 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 to the DSP HRTFs and other information to convolve the sound).

A central processing unit (CPU), processor (such as a 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 that the sound will localize to a zone or SLP. For example, the sound localizes to a 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 set of HRTF pairs includes a field/column that specifies the coordinates associated with each pair, and the coordinates indicate the location for the origination of the sound. These coordinates 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 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 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

5 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; 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-
10 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 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
15 otherwise provided to a listener).

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 origination point of a sound, the sound attenuates inversely with the distance. One meter or thereabout
20 defines a practical boundary between near-field and far-field distances and **corresponding HRTFs. A “near-field” distance is one measured at about one meter or less; whereas a “far-field” distance is one measured at about one meter or more.** Example embodiments are implemented with near-field and far-field distances.

25 The coordinates for external sound localization can be calculated or estimated 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 coordinates (r, θ, ϕ) for external sound localization can also be calculated from a measurement of an orientation of
30 and a distance to the face of the person when a head related impulse response (HRIR) is captured.

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). The 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 are 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. The data can be arranged according to one or more standard or proprietary file formats, such as AES69, and extracted 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 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. The information is quickly retrieved to enable real-time processing and convolving of sound using 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 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 the sound is provided as mono sound or stereo sound).

A location of the SLP corresponds to the coordinates of one or more pairs of HRTFs, or corresponds to a coordinate location or zone where a listener perceives a localization due to the influence of a visual cue (e.g., an image, object, or device), or a known or understood location of a sound source that is not visible (e.g., a recently
5 witnessed or anticipated location of a sound source, a device that is out of a field-of-view, an avatar suddenly occluded by another virtual object).

For example, the coordinates of or within a SLP or a zone match or approximate the coordinates of a HRTF. Consider an example in which the coordinates for a pair of
10 HRTFs are (r, θ, ϕ) and are provided as (1.2 meters, 35° , 10°). A corresponding SLP or zone intended 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 elevation angle of 10° taken with respect to a forward-looking direction of the person. In the example, the coordinates
15 of the SLP and HRTF match.

As another example, a listener perceives a SLP at a sound source of a near-field physical object and the HRTFs convolving the perceived sound have far-field coordinates along the line-of-sight from the head of the listener to the object. In this
20 case, one or more of the SLP coordinates do not match the coordinates of the object (e.g., the r coordinates do not match). HRTF pairs having coordinates matching the coordinates of the object may be unavailable to the listener. Later as the listener localizes the sound to the object, a barrier is placed such that the listener is blocked from seeing the object. The listener continues to localize the sound to the object,
25 with the object as the SLP because the listener remains aware that the object has not moved.

The listener turns around 180° so that the sound source is behind the listener, and an example embodiment updates the azimuth coordinate of the HRTFs by 180° . Though
30 the object is outside of the field of view of the listener, the listener continues to localize the sound to the location of the object that is behind the listener. The listener

having witnessed and associated the sound with the object remains aware of the source of the sound and continues to localize the sound to the location or area of the object.

- 5 SLI can also be approximated or interpolated based on known data or known SLI such as SLI for other coordinate locations. For example, a SLP is desired to localize at coordinate location (2.0 m, 0°, 40°), but HRTFs for the 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
- 10 approximated from the two known locations. These approximated HRTFs are provided to convolve sound to localize at the desired coordinate location (2.0 m, 0°, 40°).

- Sound is convolved either directly in the time domain with a finite impulse response
- 15 (FIR) filter or with a Fast Fourier Transform (FFT). For example, an electronic device convolves the sound to one or more SLPs using a set of HRTFs, HRIRs, BRIRs, or RIRs and provides the person with binaural sound.

- In an example embodiment, convolution involves an audio input signal and one or
- 20 more impulse responses of a sound originating from various positions with respect to the listener. The input signal is a limited length audio signal (such as a pre-recorded digital audio file) or an ongoing audio signal (such as sound from a microphone or streaming audio over the Internet from a continuous source). The impulse responses are a set of HRIRs, BRIRs, RIRs, etc.

- 25 Convolution applies one or more FIR filters to the input signals and convolves the input signals into binaural audio output or binaural stereo tracks. For example the input signals are convolved into binaural audio output that is specific or individualized for the listener based on one or more of the impulse responses to the listener.

- 30 The FIR filters are derived binaural impulse responses that are executed with

example embodiments discussed herein (e.g., derived from signals received through microphones placed in, at, or near the left and right ear channel entrance of the person). Alternatively or additionally, the FIR filters are obtained from another source, such as generated from a computer simulation or estimation, generated from a
5 dummy head, retrieved from storage, etc. Further, convolution of an input signal into binaural output can include sound with one or more of reverberation, single echoes, frequency coloring, and spatial impression.

Processing of the sound also includes calculating and/or adjusting an interaural time
10 difference (ITD), an interaural level difference (ILD), and/or other aspects of the sound in order to alter the cues and artificially alter the point of localization. Consider an example in which the ITD is calculated for a location (θ, ϕ) with discrete Fourier transforms (DFTs) calculated for the left and right ears. The ITD is located at the point for which the function attains its maximum value, known as the argument of the
15 maximum or $\arg \max$ as follows:

$$\text{ITD} = \arg \max(\tau) \sum_n d_{l,\theta,\phi}(n) \cdot d_{r,\theta,\phi}(n + \tau).$$

Subsequent sounds are filtered with the left HRTF, right HRTF, and/or ITD so that the
20 sound localizes at (r, θ, ϕ) . Such sounds include filtering stereo and monaural sound to localize at (r, θ, ϕ) . For example, given an input signal as a monaural sound signal $s(n)$, this sound is convolved to appear at (θ, ϕ) when the left ear is presented with:

$$s_l(n) = s(n - \text{ITD}) \cdot d_{l,\theta,\phi}(n);$$

25

and the right ear is presented with:

$$s_r(n) = s(n) \cdot d_{r,\theta,\phi}(n).$$

Consider an example in which a dedicated digital signal processor (DSP) executes frequency domain processing to generate real-time convolution of monophonic sound to binaural sound.

5

By way of example, a continuous audio input signal $x(t)$ is convolved with a linear filter of an impulse response $h(t)$ to generate an output signal $y(t)$ as follows:

$$y(\tau) = x(\tau) \cdot h(\tau) = \int_0^{\infty} x(\tau - t) \cdot h(t) \cdot dt.$$

10

This reduces to a summation when the impulse response has a given length N and the input signal and the impulse response are sampled at $t = iDt$ as follows:

$$y(i) = \sum_{j=0}^{N-1} x(i - j) \cdot h(j).$$

15

Execution time of convolution further reduces with a Fast Fourier Transform (FFT) algorithm and/or Inverse Fast Fourier Transform (IFFT) algorithm.

20 Consider another example of binaural synthesis in which recorded or synthesized sound is filtered with a binaural impulse response (e.g., HRIR or BRIR) to generate a binaural output sound to the person. The input sound is preprocessed to generate left and right audio streams that are mapped to one or more sound sources or sound localization points (known as SLPs). These streams are convolved with a binaural impulse response for the left ear and the right ear to generate the left and right

25 binaural output sound signal. The output sound signal is further processed depending on a final destination. For example a cross-talk cancellation algorithm is applied to the output sound signal when it will be provided through loudspeakers or applying artificial binaural reverberation to provide 3D spatial context to the sound.

Example embodiments designate or include an object, sound source, image, or device on the ray that extends from a head of a listener to the intended SLP (such as displaying an image as the sound source at or in line with the intended 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).

Block 940 states provide the sound to the listener as binaural sound that localizes to the listener at the sound source.

Binaural sound is provided to the listener through one or more electronic devices including, but not limited to, one or more of bone conduction headphones, speakers of a wearable electronic device (e.g., headphones, earphones, electronic glasses, earbuds, head mounted display, smartphone, etc.). 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 object, point, area, or location that corresponds with the SLP. For example, an example embodiment selects an intended SLP at, on, or near a physical object, a VR object, or an AR object that is or represents the sound source (including locations behind the object or sound source). When the sound is convolved with HRTFs corresponding to the intended SLP (including HRTFs behind the intended SLP), then the sound appears to originate to the listener at the object.

When binaural sound is provided to the listener, the listener will hear the sound as if it originates from the sound source. The sound, however, does not originate from the sound source since the sound source may be an inanimate object with no electronics or an animate object with no electronics. Alternatively, the sound source has electronics but does not have the capability to generate sound (e.g., the sound

source has no speakers or sound system). As yet another example, the sound source has speakers and the ability to provide sound but is not providing sound to the listener. In each of these examples, the listener perceives the sound to originate from the sound source, but the sound source does not produce the sound. Instead, the
5 sound is altered or convolved and provided to the listener so the sound appears to originate from the sound source.

Sound localization information (SLI) is stored and categorized in various formats. For example, tables or lookup tables store SLI for quick access and provide convolution
10 instructions for sound. Information stored in tables expedites retrieval of stored information, reduces CPU time required for sound convolution, and reduces a number of instruction cycles. Storing SLI in tables also expedites and/or assists in prefetching, preprocessing, caching, and executing other example embodiments discussed herein.

15 Consider an example in which a HPED determines an identity of a listener (e.g., with a biometric sensor such as one discussed herein) and retrieves HRTFs associated with the identified listener. For example, a HPED captures, with a camera in the HPED, the face of a first user during telephony with a second user. Facial recognition
20 software analyzes the facial image of the first user to determine his or her identity. Memory stores HRTFs for different users (e.g., personalized HRTFs or preferred HRTFs). Based on the identity of the user, the HPED retrieves far-field HRTFs that are assigned to the first user. A processor in the HPED or a process in a server in communication with the HPED convolves the voice of the second user with the
25 selected far-field HRTFs. When the camera no longer detects or recognizes the face of the first user, the HPED changes the voice of the second user from localizing as the binaural sound to localizing as one of mono sound or stereo sound.

In an example embodiment, the HRTFs and SLI being executed to convolve the
30 sound can switch or change depending on whether the distance of the listener to the sound source is near-field or far-field. Consider an example in which a display

displays a sound source to a listener who is two meters away from the sound source. When the listener is two meters away from the sound source, the listener is a far-field distance from the sound source. The example embodiment convolves the sound with far-field HRTFs with coordinate locations that correspond to the location of the sound source. The coordinate locations of the SLI correspond or match the coordinate locations of the sound source. The listener then moves closer to the sound source and is within a near-field distance to the sound source, say within 0.5 meters of the sound source. Instead of convolving the sound to the location of the sound source which would require near-field HRTFs, an example embodiment switches or changes convolution to convolve the sound to a location that is behind the sound source so far-field HRTFs can continue to be used to convolve the sound. For example, the example embodiment selects far-field HRTFs with a distance of 1.0 meters and adjusts the SLI accordingly. The sound is actually convolved with SLI to coordinates located 1.0 meters away from the listener which would be 0.5 meters behind the sound source. The listener, though, perceives the sound as originating from the sound source even though the coordinate locations of the HRTFs do not match the coordinate location of the sound source (e.g., here, the HRTFs have a distance of 1.0 meters while the sound source has a distance of 0.5 meters from the listener). This example illustrates one way in which convolution of the sound changes based on a distance of the listener to the sound source. The example embodiment continues to convolve the sound with far-field HRTFs even when the listener is a near-field distance to the sound source.

Figure 10 is a method that convolves, during a telephone call, a voice of a sound source to a location behind the sound source in accordance with an example embodiment.

Block 1000 states simultaneously display, with an electronic device, two or more sound sources to a person during a telephone call.

For example, a display of an HPED simultaneously displays two or more sound

sources that represent users to the telephone call. For instance, each person to a conference call or video call is displayed on the display.

5 For example, a wearable electronic device (e.g., electronic glasses, a HMD, or a smartphone worn on a head of a person) displays an AR or VR image of each user to the telephone call.

10 The sound sources include the wearer or holder or user of the electronic device. For example, a caller calls a person who wears or holds a portable electronic device, and this electronic device displays an image of a caller and also an image of the person to the person during the telephone call.

15 Block 1010 states convolve and/or process, during the telephone call, at least one voice of the one sound source being displayed with HRTFs having coordinate locations located behind the one sound source being displayed.

20 In an example embodiment, the coordinate location of the HRTFs for a sound source is directly behind the sound source. For instance, the coordinate location is located 0.1 m – 1.0 m behind the location of the sound source. Further, the coordinate location is located on or about on a line-of-sight from the person to the sound source or on or near a ray extending from the center of the head of the person to the representation of a caller or sound on the telephone call.

25 The coordinate location of the HRTFs can be located off or away from the ray/line-of-sight or at an angle with respect to the ray or line-of-sight. For example, the coordinate location of the HRTFs is angled from the line-of-sight by an azimuth angle (θ) and/or elevation angle (ϕ) of 1°, 2°, 3°, 4°, 5°, 6°, 7°, 8°, 9°, 10°, 15°, 20°, or 25°.

30 Figure 11 is a computer system or electronic system 1100 in accordance with an example embodiment. The computer system includes one or more of a portable electronic device or PED 1102, one or more computers or electronic devices (such as

one or more servers) 1104, and storage or memory 1108 in communication over one or more networks 1110.

5 The portable electronic device 1102 includes one or more components of computer readable medium (CRM) or memory 1120 (such as cache memory and memory storing instructions to execute one or more example embodiments), a display 1122, a processing unit 1124 (such as one or more processors, microprocessors, and/or microcontrollers), one or more interfaces 1126 (such as a network interface, a graphical user interface, a natural language user interface, a natural user interface, a
10 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 (SLS) 1128, head tracking 1130, a digital signal processor (DSP) 1132, and one or more sensors 1134 (such as a camera, proximity sensor, or other sensor discussed herein).

15 The PED 1102 communicates with wired or wireless headphones or earphones 1103 that include speakers 1140 and/or other electronics (such as microphones).

The storage 1108 includes one or more of memory or databases that store one or
20 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 locations and sound localization preferences), impulse responses and transfer functions (such as HRTFs, HRIRs, BRIRs, and RIRs), and other information discussed herein.

25 The network 1110 includes one or more of a cellular network, a public switch telephone network, the Internet, a local area network (LAN), a wide area network (WAN), a metropolitan area network (MAN), a personal area network (PAN), home area network (HAM), and other public and/or private networks. Additionally, the
30 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 devices communicate directly through a wireless protocol, such as Bluetooth, near field communication (NFC), or other wireless communication protocol.

- 5 Electronic device 1104 (shown by way of example as a server) includes one or more components of computer readable medium (CRM) or memory 1160 (including cache memory), a processing unit 1164 (such as one or more processors, microprocessors, and/or microcontrollers), a sound localization system 1166, and an audio or sound convolver 1168.

10

The electronic device 1104 communicates with the PED 1102 and with storage or memory that stores sound localization information (SLI) 1180, 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

15 transfer functions and/or impulse responses and other SLI are stored in memory 1120 or another location, such as storage 1108.

Figure 12 is a computer system or electronic system in accordance with an example embodiment. The computer system 1200 includes one or more of a portable

20 electronic device 1202, a server 1204, a portable electronic device 1208 (including wearable electronic devices and handheld portable electronic devices), and a display 1205 in communication with each other over one or more networks 1212.

Portable electronic device 1202 includes one or more components of computer

25 readable medium (CRM) or memory 1220 (including cache memory), one or more displays 1222, a processor or processing unit 1224 (such as one or more microprocessors and/or microcontrollers), one or more sensors 1226 (such as a micro-electro-mechanical systems sensor, a proximity sensor, a biometric sensor, an optical sensor, a radio-frequency identification sensor, a global positioning satellite

30 (GPS) sensor, a solid state compass, a gyroscope, a magnetometer, and/or an accelerometer), earphones with speakers 1228, sound localization information (SLI)

1230, an intelligent user agent (IUA) and/or intelligent personal assistant (IPA) 1232, sound hardware 1234, and a SLP selector 1238.

5 Server 1204 includes computer readable medium (CRM) or memory 1250, a processor or processing unit 1252, and a DSP 1254 and/or other hardware to convolve audio in accordance with an example embodiment.

10 Portable electronic device 1208 includes computer readable medium (CRM) or memory 1260 (including cache memory), one or more displays 1262, a processor or processing unit 1264, one or more interfaces 1266 (such as interfaces discussed herein in Figure 11), sound localization information 1268 (e.g., stored in memory), a sound localization point (SLP) selector 1270, user preferences 1272, one or more digital signal processors (DSP) 1274, one or more of speakers and/or microphones 1276, head tracking and/or head orientation determiner 1277, a compass 1278,
15 inertial sensors 1279 (such as an accelerometer, a gyroscope, and/or a magnetometer), and a camera 1280.

A sound localization point (SLP) selector includes specialized hardware and/or software to execute example embodiments that select a desired SLP for where
20 binaural sound will localize to a user and/or select coordinate locations of HRTFs being executed to convolve the sound.

A sound localization system (SLS) and SLP selector include one or more of a processor, core, chip, microprocessor, controller, memory, specialized hardware, and
25 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 customized system-on-chip (SoC) to select, assign, and/or designate a SLP or a coordinate location for sound or convolve sound with SLI to generate binaural sound. For
30 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 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 coordinate locations for sound or
5 convolving, processing, or preprocessing sound so the sound externally localizes to the listener.

The sound localization system (SLS) performs various tasks with regard to managing, generating, interpolating, extrapolating, retrieving, storing, and selecting SLPs and
10 coordinate locations and can function in coordination with and/or be part of the processing unit and/or DSPs or can incorporate DSPs. These tasks include, determining coordinates of SLPs and other coordinate locations and their corresponding HRTFs, switching and/or changing sound between binaural sound and mono sound or stereo sound, selecting SLPs and/or coordinate locations of HRTFs
15 for a user, selecting sound sources to which sound will localize to a user, designating a type of sound, segment of audio, or sound source, providing binaural sound to users at a SLP, prefetching and/or preprocessing SLI, and executing one or more other blocks discussed herein. The sound localization system can also include a sound convolving application that convolves and de-convolves sound according to
20 one or more audio impulse responses and/or transfer functions based on or in communication with head tracking.

In an example embodiment, the SLS calculates the line-of-sight or imaginary line from the head of the listener to the sound source and retrieves SLI (including HRTFs)
25 based on the location of the line. For instance, two points or locations determine a line. One point is located at the head of the listener. Information about the head orientation of the listener can be determined from or calculated from a camera or a head tracking and/or head orientation determiner (e.g., hardware and/or software in a head mounted display or other wearable electronic device). A second point is located
30 at the origin of the sound, such as the electronic device, sound source, etc. Information about the location of the second point can be determined from or

calculated from a camera, a sensor, tag or RFID, or an electronic device. For instance, an electronic device calculates its position with respect to a head of the listener using one or more of a camera, facial recognition, a MEMS sensor (e.g., a multi-axis sensor with 9 degrees of freedom), wireless short-range communication
5 with another electronic device (e.g., communication between an HPED and a wearable electronic device or electronic device in an Internet-of-Things (IoT) network), or other method.

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 requests between the user, IPA,
15 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 or video to play, or text or images to display), timely or passive data collection or information-gathering from persons or users (such as querying a user for information),
20 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 or finance management), and providing recommendations. By way of example, these tasks or services are based on one or more of user input, prediction, activity awareness, location awareness, an
25 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 chip. A sound card includes one or more of a digital-to-analog (DAC) converter, an analog-
30 to-digital (ATD) converter, a line-in connector for an input signal from a source of sound, 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 a portable electronic device include, but are not limited to, handheld portable electronic devices (HPEDs), wearable electronic glasses, smartglasses, 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 and/or sound hardware as discussed herein).

The SLP selector and/or SLS can also execute retrieving SLI, preprocessing, predicting, and caching including, but not limited to, predicting an action of a user, predicting a location of a user, predicting motion of a user such as a gesture, a change in a head displacement and/or orientation, predicting a trajectory of a sound localization to a user, predicting an event, predicting a desire or want of a user, predicting a query of a user (such as a query to or response from an intelligent

personal assistant), predicting and/or recommending a SLP, zone, or RIR/RTF 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, hardware, an electronic device, and/or user agent are modeled as a prediction that the user will take an action and/or desire or benefit from moving or muting a SLP, 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 including, but not limited to, a prediction of times, locations, or identities of incoming callers or virtual sound source requests for sound localizations to the user, a type or quality of inbound sound, predicting a sound source or virtual sound source path including a change in orientation of the sound source or virtual sound source or SLP such as a change in a direction of source emission of the SLP.

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.

5 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
10 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.

15

Consider an example embodiment in which the SLS includes 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
20 combinational functions for the SLS (e.g., changing between binaural sound and mono sound upon detecting rotation of the HPED or detecting another action discussed herein).

Consider an example in which the SLS includes an integrated circuit or ASIC that is
25 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 and/or blocks of methods discussed herein).

30

Consider an example in which the SLS includes 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 customized processor or microprocessor or semiconductor intellectual property (SIP) core or digital signal processor (DSP) with a hardware architecture optimized for
5 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
10 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 prefetch multiple data and/or instructions concurrently to increase execution speed and sound
15 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
20 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
25 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. For example, the
30 SLP selector 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.

Consider another example in which HRTFs (such as a custom or personal set of HRTFs created for a certain user or users, 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.

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 images or SLPs for the sound on a user interface of a HPED. Further, the DSPs simultaneously convolve multiple sound sources or SLPs to a user. These sound sources or SLPs can be moving with respect to the face of the user so the DSPs convolve multiple different sound signals and virtual sound sources with HRTFs that are continually, continuously, or rapidly changing.

As used herein, the word “about” when indicated with a number, amount, time, etc. is close or near something. By way of example, for spherical or polar coordinates of a SLP (r , θ , ϕ), the word “about” means plus or minus ($\pm$) three degrees for θ and ϕ and plus or minus 5% for distance (r).

As used herein, “empty space” is a location that is not occupied by a tangible object.

As used herein, “field-of-view” is the observable world that is seen at a given moment. Field-of-view includes what a user or camera sees in a virtual or augmented world (e.g., what the user sees while wearing a HMD or OHMD).

As used herein, “line-of-sight” is a line from an observer’s eye to a location.

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, “sound localization information” or “SLI” is information that an electronic device uses to process or convolve sound so the sound externally localizes as binaural sound to a listener. Examples of SLI include head related transfer functions (HRTFs), head related impulse responses (HRIRs), binaural room impulse responses (BRIRs), room impulse responses (RIRs), interaural level differences (ILDs), and interaural time differences (ITDs).

As used herein, a “sound localization point” or “SLP” is a location where a listener localizes sound. A SLP can be internal (such as monaural sound that localizes inside a head of a listener wearing headphones or earbuds), 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 zone or shape or volume or general area, such as a line or a cylindrical volume. Further, in some instances, multiple impulse responses or transfer functions can process or convolve sounds to a place within the boundary of the SLP. In some instances, HRTFs necessary to produce a particular SLP for a particular user may not have been created. A HRTF may not be required to provide a SLP or localize sound for a user, such as for an internalized SLP, or a SLP may be rendered by adjusting an ITD and/or ILD or other human audial cues.

A “sound source” and a “source of sound” are interchangeable and are a real or virtual object or location to where a listener localizes binaural sound, such as an object to which a listener externally localizes binaural sound. Examples include, but are not limited to, an electronic device, an image, a physical or real or tangible object, a virtual object or VR image, a video, a picture, an AR image, a virtual sound source, a display, a location from where a listener is intended to localize binaural sound, a combination of one or more of these examples, and other examples provided herein.

As used herein, “spherical coordinates” or “spherical coordinate system” provides a coordinate system in 3D space in which a position is given with three numbers: a radial distance (r) from an origin, an azimuth angle (θ) of its orthogonal projection on a reference plane that is orthogonal to the zenith direction and that passes through
5 the origin, and an elevation or polar angle (ϕ) that is measured from the zenith direction.

As used herein, a “telephone call,” or a “phone call” or “telephony” is a connection over a wired and/or wireless network between a calling person or user and a called
10 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,
15 Personal Area Networks or PANs, home area networks or HAMs, Campus Area Networks or CANs, etc.). Telephone calls include other types of telephony including Voice over Internet Protocol (VoIP) calls, video calls, conference calls, internet telephone calls, in-game calls, telepresence, etc.

20 As used herein, “three-dimensional space” or “3D space” is space in which three 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).

25 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 or points of virtual
30 microphones in or at its ears).

As used herein, a “video call” is a telephone call in which one or more people to the video call see video of the other person.

As used herein, a “virtual sound source” is a sound source in virtual auditory space (aka virtual acoustic space). For example, listeners hear a virtual sound source at one or more SLPs.

Impulse responses can be transformed into their respective transfer functions. For example, a RIR has an equivalent transfer function of a RTF; a BRIR has an equivalent transfer function of a BRIR; and a HRIR has an equivalent transfer function of a HRTF.

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 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 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 (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 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
5 instruction from a user.

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
10 structures; other data and other database structures can be 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.
15 Such specific information is not provided to limit example embodiments.

CLAIMS

What is claimed is:

1. A method that improves a user experience during a video call between a first user and a second user when the first user holds a handheld portable electronic device (HPED) less than one meter away from a face of the first user, the method comprising:

displaying, on a display of the HPED and while the first user holds the HPED less than one meter away from the face of the first user, the second user engaged in the video call with the first user; and

improving the user experience of the first user during the video call by convolving, with a processor, a voice of the second user with far-field head related transfer functions (HRTFs) to a location behind the HPED relative to the face of the first user so the first user perceives an origin of the voice of the second user as originating from the HPED while the HPED is a near-field distance from the face of the first user.

2. The method of claim 1 further comprising:

sensing, with the HPED, a flick rotation of at least ninety degrees (90°) of the HPED while the first user holds the HPED; and

switching, in response to sensing the flick rotation, from providing the voice of the second user to the first user in the binaural sound to providing the voice of the second user to the first user in one of mono sound or stereo sound.

3. The method of claim 1 further comprising:

capturing, with a camera in the HPED, a head orientation of the first user; and

changing the voice of the second user from localizing as the binaural sound to localizing inside a head of the first user in response to the HPED

detecting a change in the head orientation of forty-five (45°) along one of an azimuth direction or an elevation direction.

4. The method of claim 1 further comprising:

detecting, with a camera in the HPED, a change in a head orientation with respect to the display of the HPED; and

providing, in response to detecting the change in the head orientation with respect to the display of the HPED, the voice of the second user to the first user in one of mono sound and stereo sound.

5. The method of claim 1 further comprising:

detecting, with a camera in the HPED, when a lens of the camera is blocked;

ceasing, in response to detecting that the lens of the camera is blocked, to provide the voice of the second user to the first user in the binaural sound; and

providing, in response to detecting that the lens of the camera is blocked, the voice of the second user to the first user in one of mono sound and stereo sound.

6. The method of claim 1, wherein the location that is in empty space is located directly behind the HPED and on a line-of-sight of the first user that has an azimuth angle (θ) of zero degrees (0°).

7. The method of claim 1, wherein the location behind the HPED is located along a line-of-sight in which a distance (d_1) from a face of the first user to the HPED is $0.0 \text{ meters} < d_1 \leq 0.5 \text{ meters}$ and a distance (d_2) from the face of the first user to the location is $1.0 \text{ meters} \leq d_2 \leq 1.5 \text{ meters}$.

8. A method that improves a user experience during a telephone call between a first user and a second user, the method comprising:

displaying, to the first user and on a display of a handheld portable electronic device (HPED), an image of the second user during the telephone call; and

improving the user experience of the first user during the telephone call by convolving, with a processor, a voice of the second user with far-field head related transfer functions (HRTFs) to a location behind the HPED relative to the first user so the first user perceives an origin of the voice of the second user as originating from the HPED while the HPED is a near-field distance from a face of the first user.

9. The method of claim 8 further comprising:

detecting, with the HPED, a rotation of at least ninety degrees (90°) of the HPED; and

changing, in response to sensing the rotation, the voice of the second user from being in the binaural sound to being in one of mono sound and stereo sound.

10. The method of claim 8 further comprising:

detecting, with a camera in the HPED, that the face of the first user is less than one meter away from the HPED during the telephone call, wherein the processor convolves the voice of the second user to the location that is behind the HPED in response to detecting that the face of the first user is less than one meter away from the HPED.

11. The method of claim 8 further comprising:

capturing, with a camera in the HPED, the face of the first user;

recognizing, with facial recognition and based on the face captured with the camera, the face of the first user;

retrieving, based on recognizing the face captured with the camera, the far-field HRTFs that are stored in memory and assigned to the face; and

changing the voice of the second user from localizing as the binaural sound to localizing as one of mono sound or stereo sound when the face of the first user is no longer recognized in images captured with the camera.

12. The method of claim 8 further comprising:

detecting, with a camera in the HPED, when a head of the first user moves so the first user is no longer looking at the HPED; and
providing, in response to detecting that the first user is no longer looking at the HPED, the voice of the second user to the first user in one of mono sound and stereo sound.

13. The method of claim 8 further comprising:

detecting, with a camera in the HPED, a right facial profile of the first user;
and
moving, in response to detecting the right facial profile, the location where the voice of the second user localizes to the first user to having a location with an azimuth coordinate (θ) of greater than positive seventy degrees ($+70^\circ$) and less than positive one hundred degrees ($+100^\circ$) **such that $+70^\circ \leq \theta \leq 100^\circ$** with respect to a line-of-sight of the first user.

14. The method of claim 8 further comprising:

simultaneously displaying, on the display of the HPED, the image of the second user side-by-side with an image of the first user; and
providing the location behind the HPED where the voice of the second user localizes to the first user at an angle with respect to a line-of-sight that extends to a center of the display of the HPED.

15. A method that improves a user experience when a first user and a second user talk to each other in a telephone call, the method comprising:

displaying, on a display of a handheld portable electronic device (HPED), the second user to the first user during the telephone call;

capturing, with a camera in the HPED, a face of the first user during the telephone call; and

improving the user experience of the first user during the telephone call by convolving, with a processor and with head related transfer functions (HRTFs) having a coordinate location behind the HPED, a voice of the second user so the voice of the second user localizes to the first user as binaural sound and the first user perceives an origin of the voice of the second user as originating from the HPED even though the HRTFs have the coordinate location behind the HPED.

16. The method of claim 15 further comprising:

detecting, with an accelerometer in the HPED, a rotation of the HPED; and
changing, in response to sensing the rotation, the voice of the second user from being in the binaural sound to being in one of mono sound and stereo sound.

17. The method of claim 15 further comprising:

tracking, with a camera in the HPED, the first user during the telephone call; and
automatically switching the voice of the second user from the binaural sound to one of mono sound or stereo sound when the first user moves greater than two meters away from the HPED.

18. The method of claim 15 further comprising:

tracking, with a camera in the HPED, movements of a head of the first user; and
changing the voice of the second user from the binaural sound to mono sound and from the mono sound back to the binaural sound as the movements of the head change from being directed toward the HPED to being directed away from the HPED.

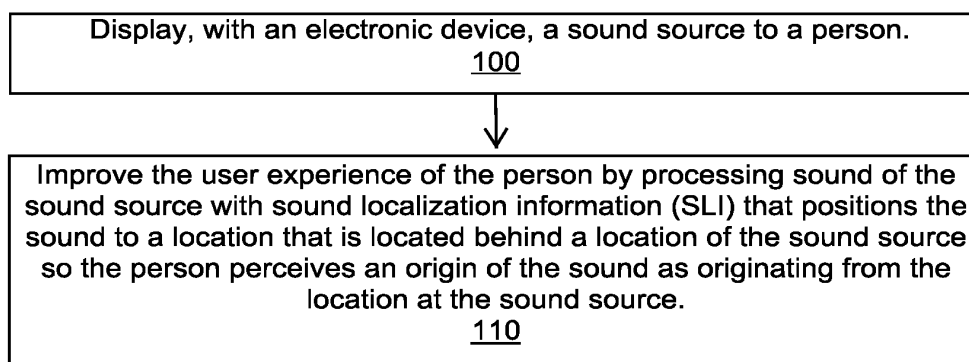
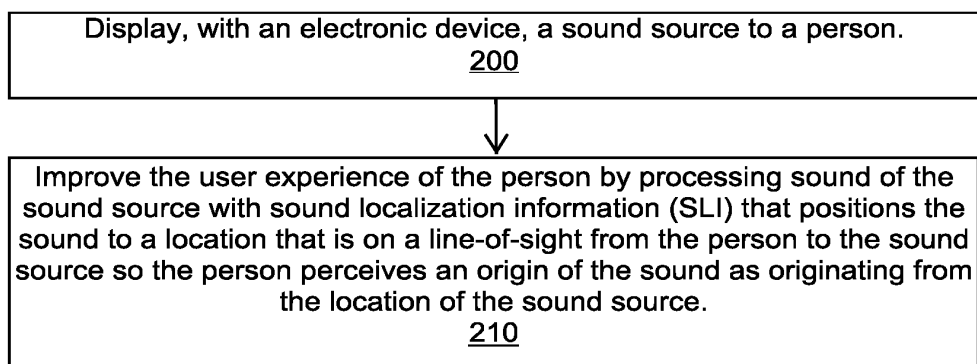
19. The method of claim 15 further comprising:

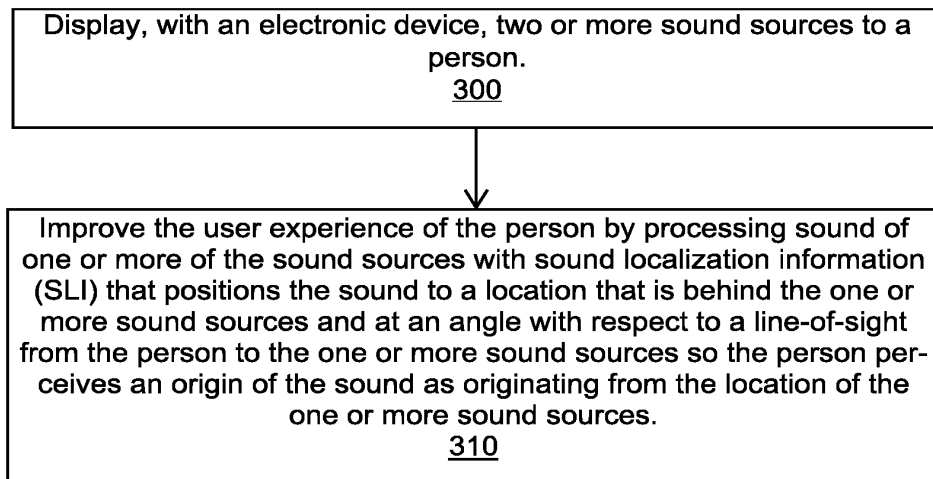
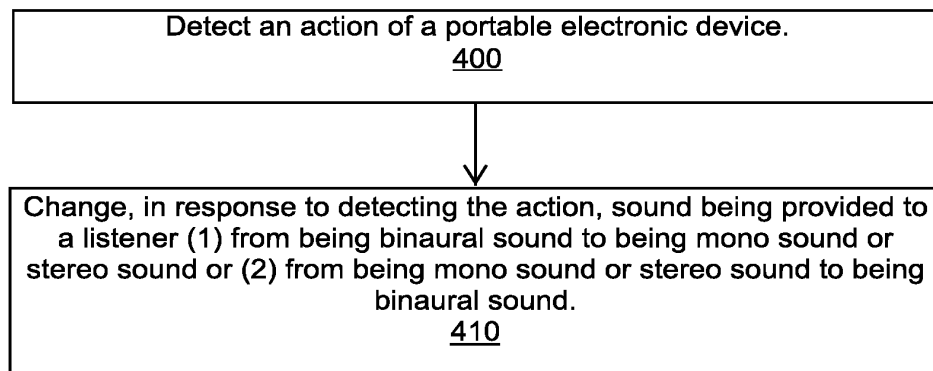
determining, with the HPED and based on the face captured with the camera, that the HPED is located in front of the face of the first user and less than one meter away from the face of the first user during the telephone call, wherein the processor convolves the voice of the second user to localize to the location that is in front of the face of the first user and farther than the HPED in response to determining that the HPED is located in front of the face of the first user and less than one meter away from the face of the first user.

20. The method of claim 15, wherein the location behind the HPED is a distance (d) from the HPED such that $d \geq 0.5$ meters.

ABSTRACT

Methods and apparatus improve a user experience during telephone calls or other forms of communication in which a listener localizes electronically generated binaural sounds. The sound is convolved or processed to a location that is behind or near a source of the sound so that the listener perceives the location of the sound as originating from the source of the sound.

**Figure 1****Figure 2**

**Figure 3****Figure 4**

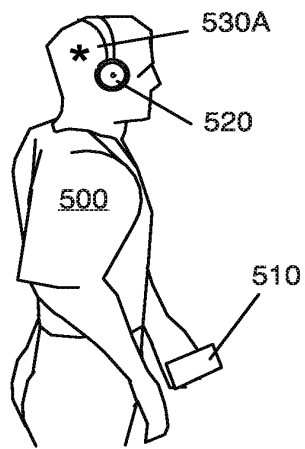


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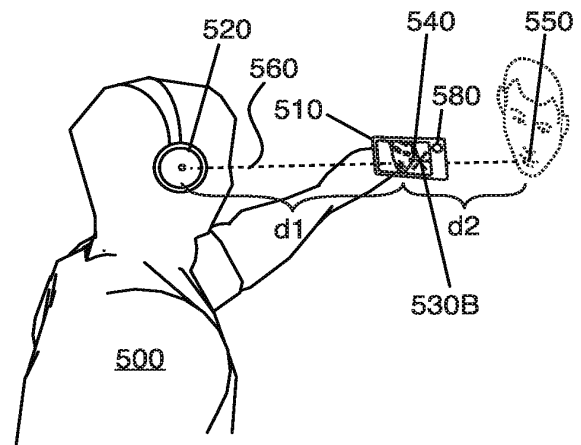


Figure 5B

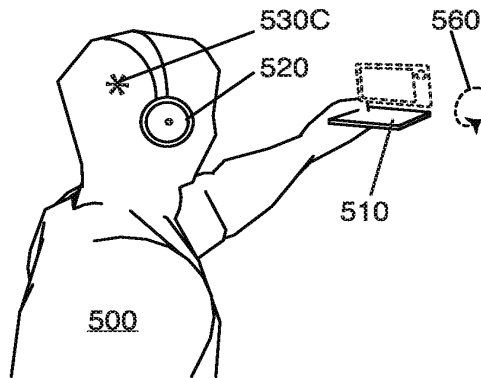


Figure 5C

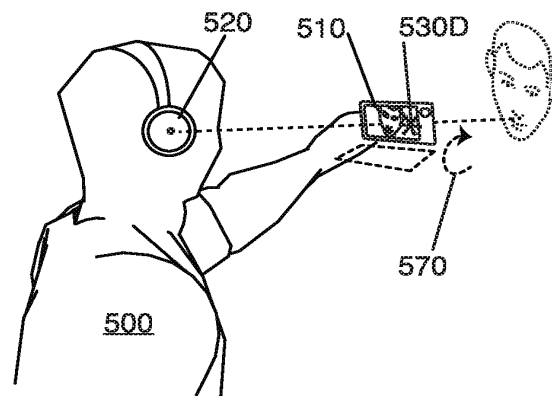


Figure 5D

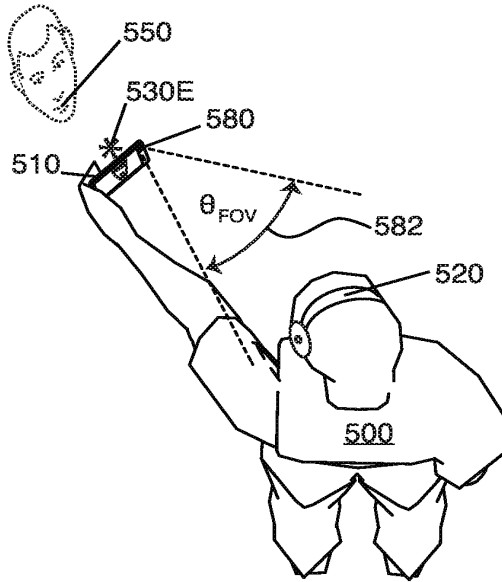


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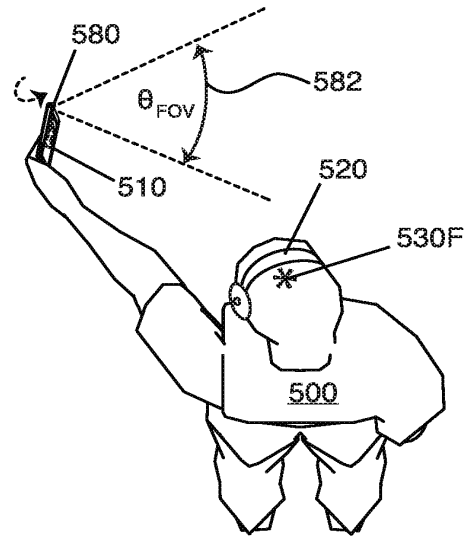


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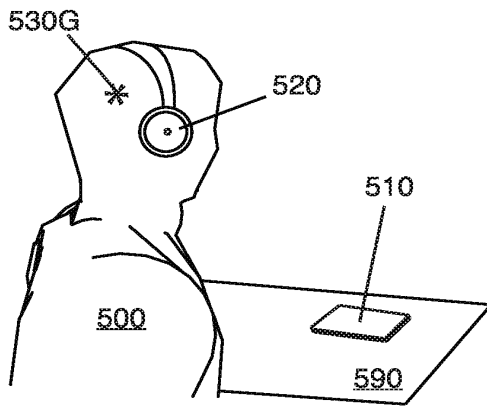


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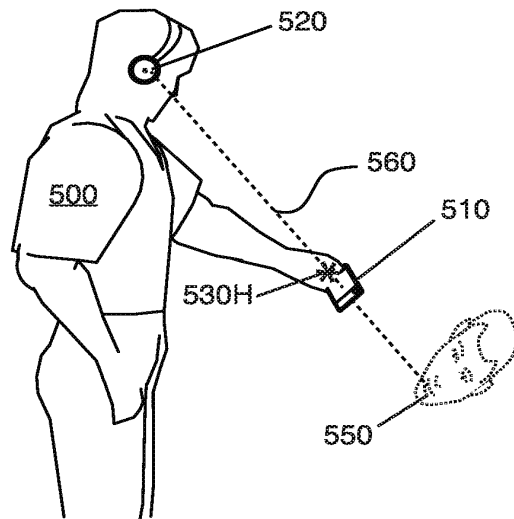


Figure 5H

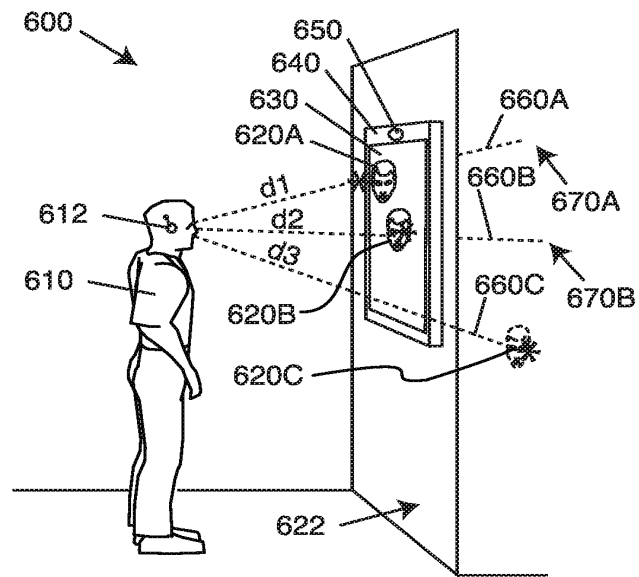


Figure 6A

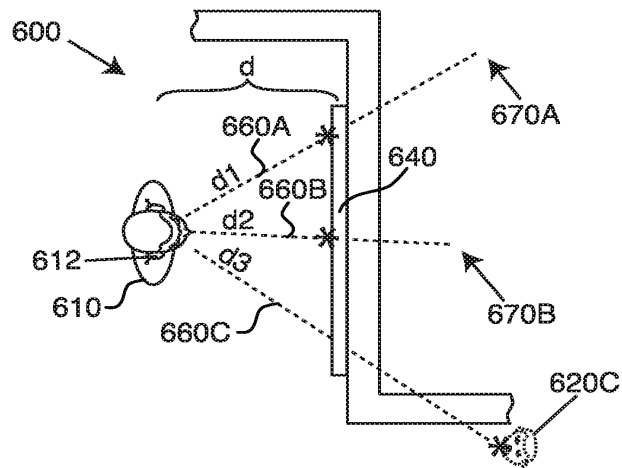


Figure 6B

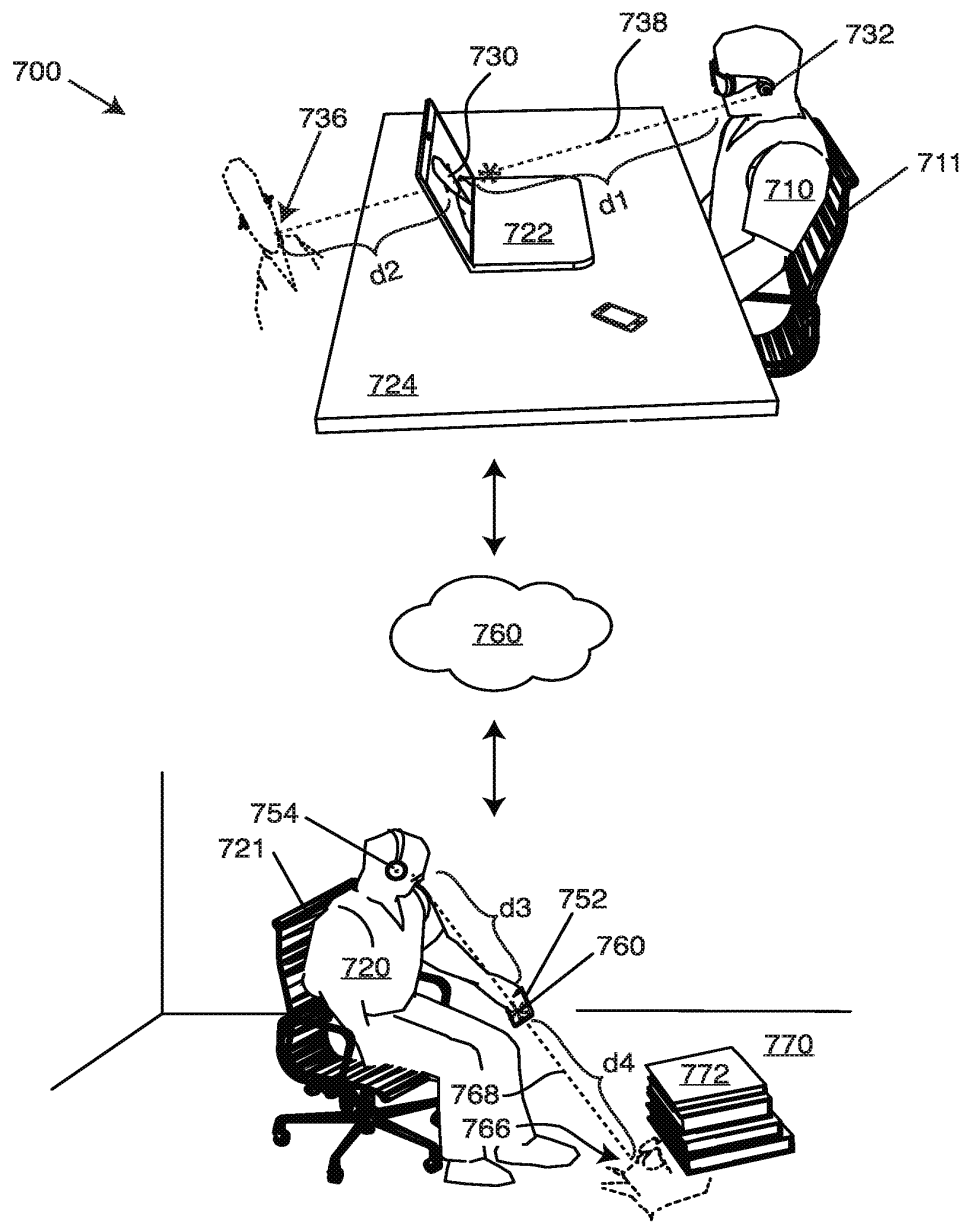


Figure 7

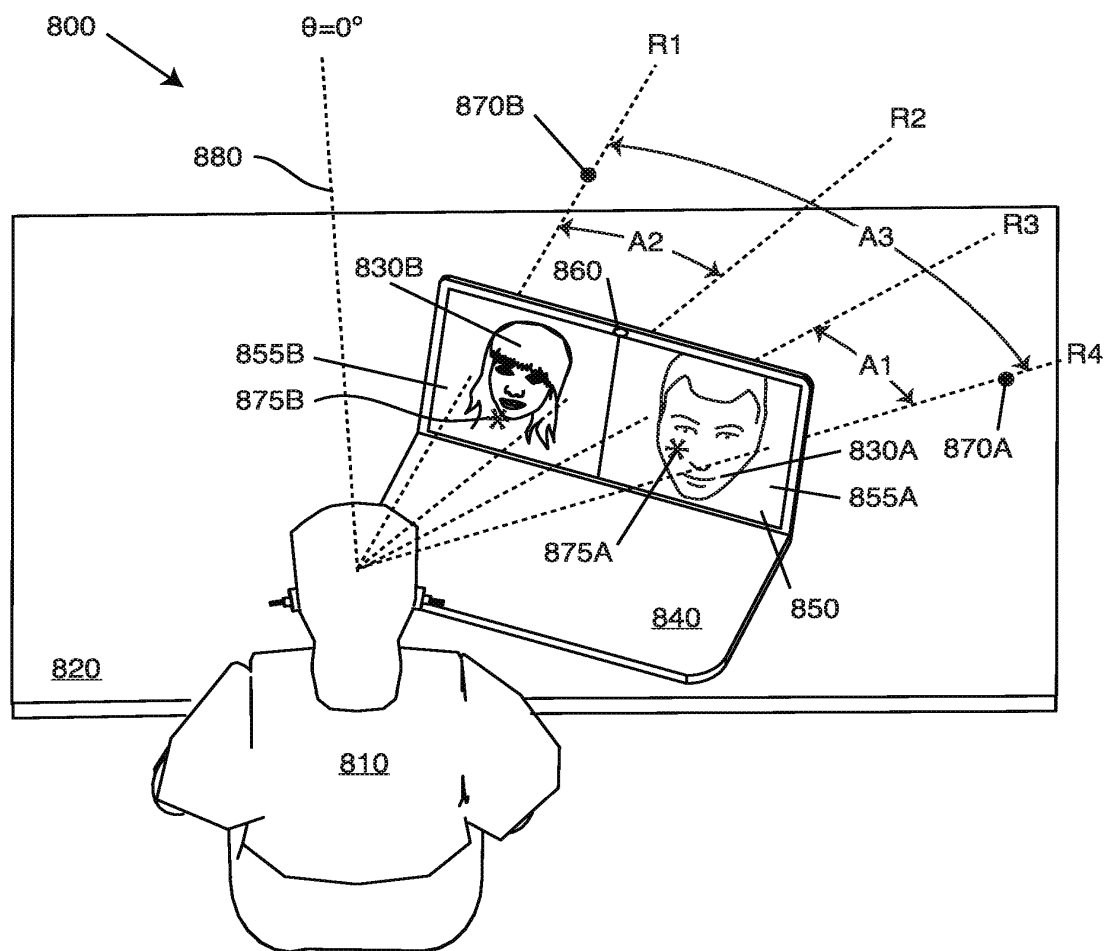


Figure 8A

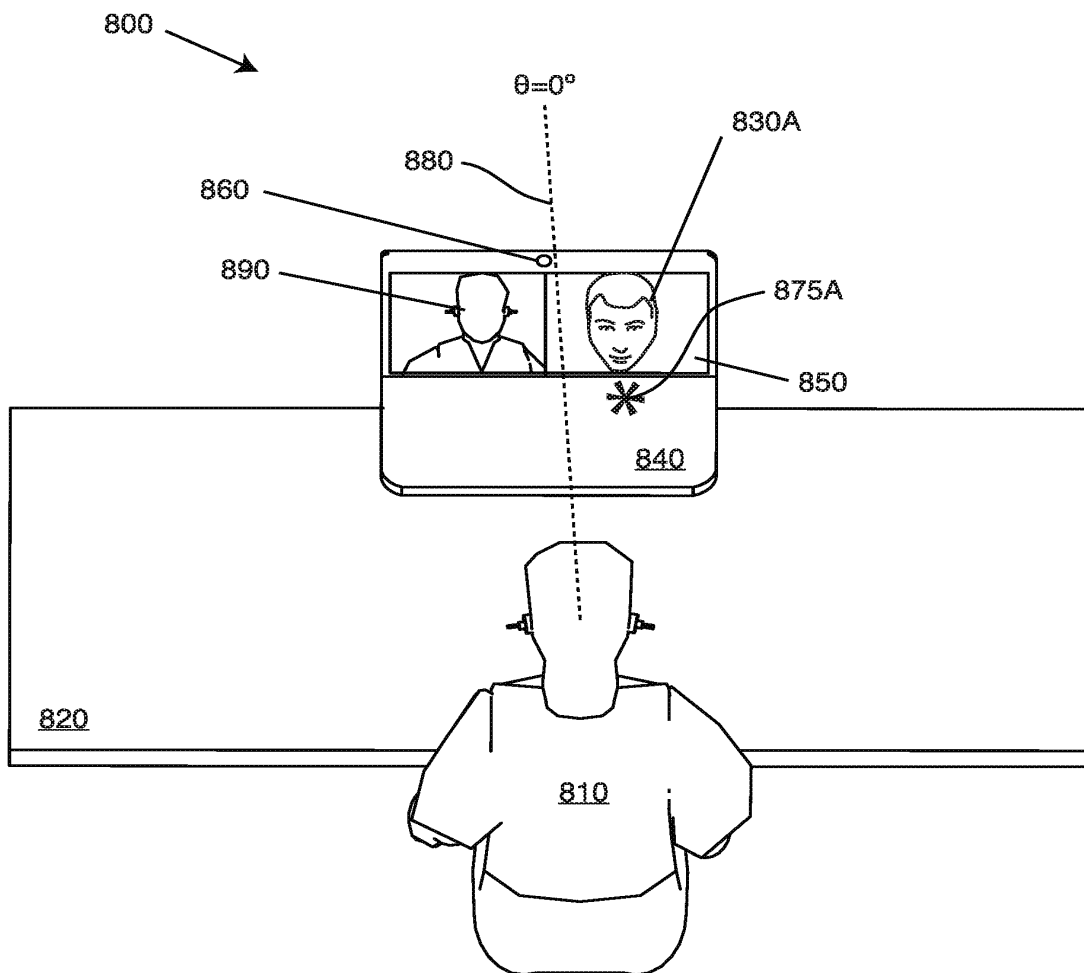
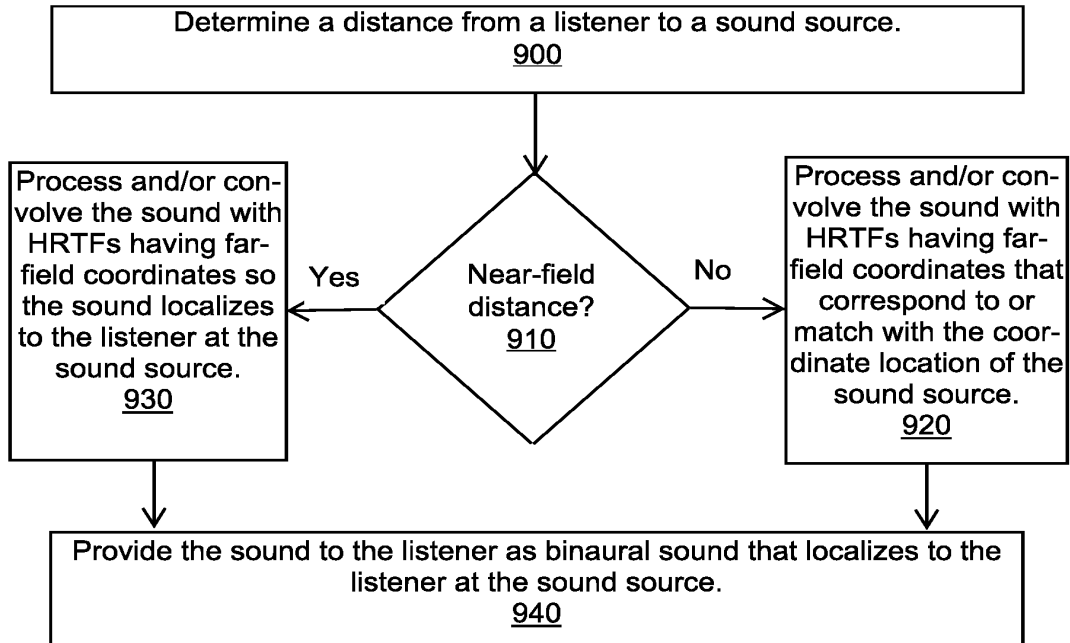
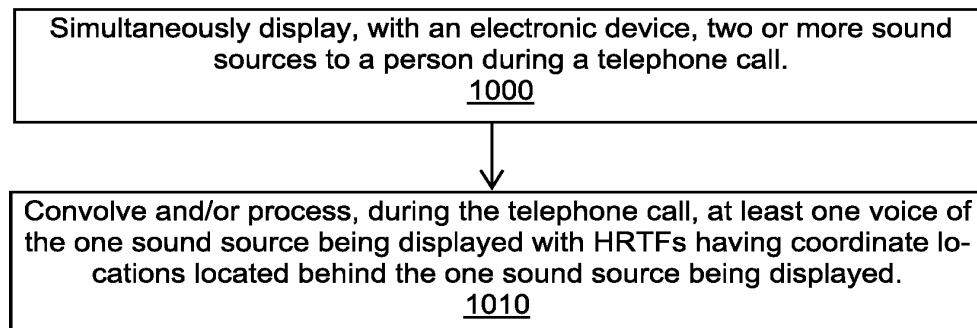
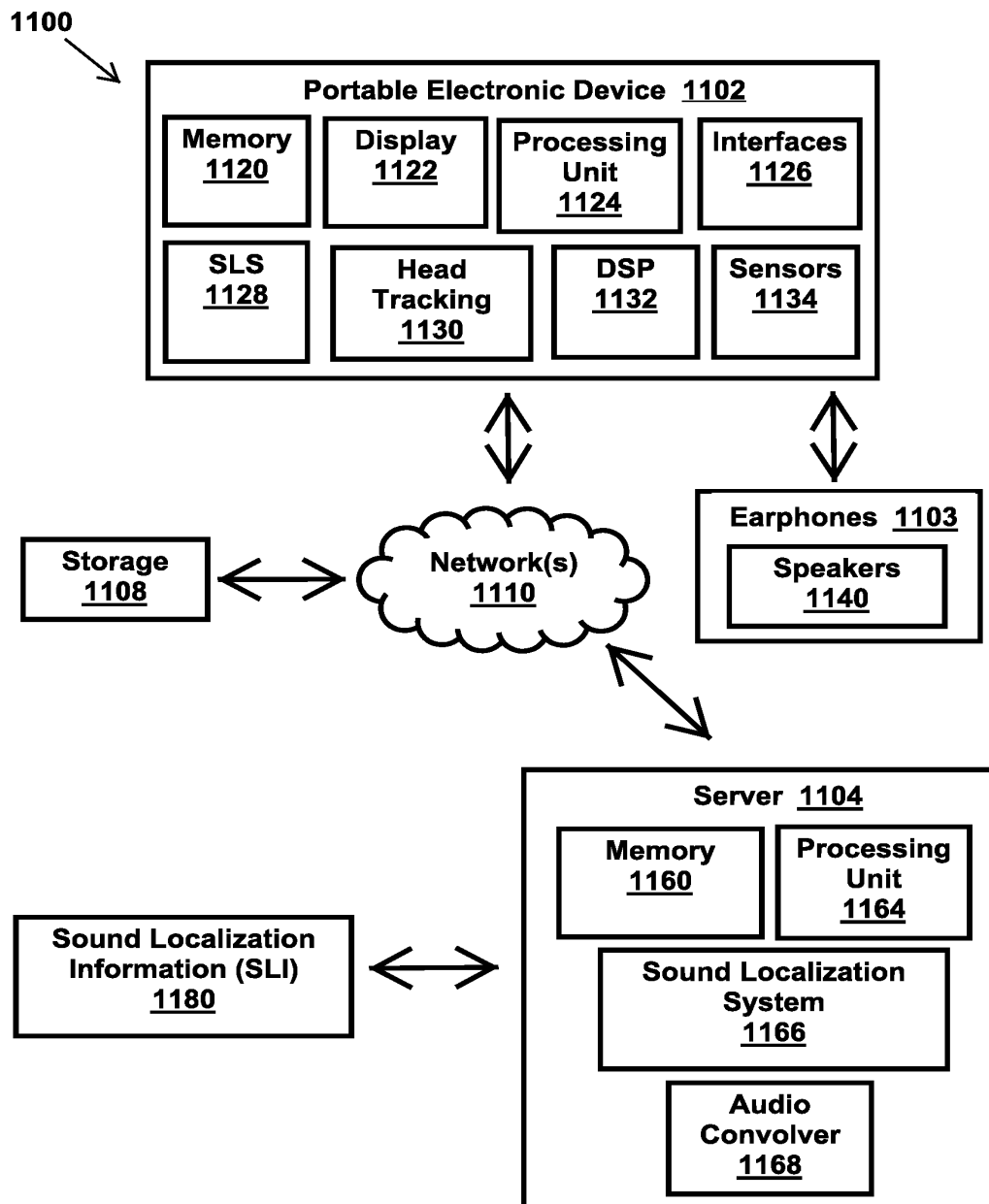


Figure 8B

**Figure 9****Figure 10**

**Figure 11**

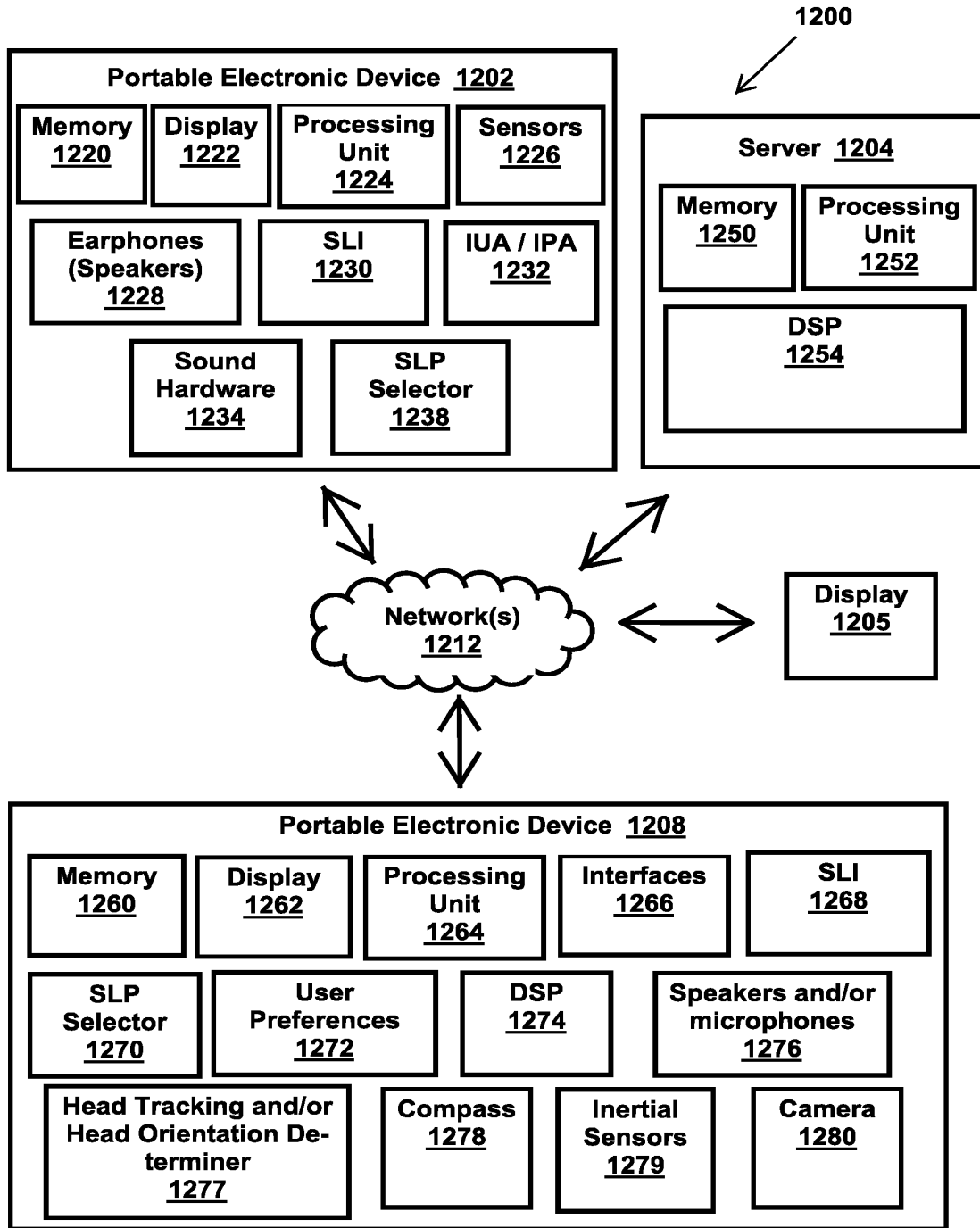


Figure 12

Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		Improving a User Experience Localizing Binaural Sound During a Telephone Call		
First Named Inventor/Applicant Name:		Glen A. Norris		
Filer:		Philip Scott Lyren		
Attorney Docket Number:		PSL-047 (CON 3)		
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	80	80
UTILITY SEARCH FEE	2111	1	350	350
UTILITY EXAMINATION FEE	2311	1	400	400
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 (\$)				830

Electronic Acknowledgement Receipt	
EFS ID:	40754019
Application Number:	17062637
International Application Number:	
Confirmation Number:	2878
Title of Invention:	Improving a User Experience Localizing Binaural Sound During a Telephone Call
First Named Inventor/Applicant Name:	Glen A. Norris
Customer Number:	64021
Filer:	Philip Scott Lyren
Filer Authorized By:	
Attorney Docket Number:	PSL-047 (CON 3)
Receipt Date:	05-OCT-2020
Filing Date:	
Time Stamp:	00:15:14
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	DA
Payment was successfully received in RAM	\$830
RAM confirmation Number	E202005115379675
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	91922	no	1
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Warnings:					
Information:					
2	Power of Attorney	Power_Attorney.pdf	247822	no	1
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3	Application Data Sheet	Application_Data_Sheet.pdf	1819398	no	7
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5	Specification	Specification.pdf	565702	no	74
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7	Abstract	Abstract.pdf	7781	no	1
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