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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
62/289,085	01/29/2016	Stephen V. Mangiat	MLEAP.012PR2

CONFIRMATION NO. 1043

POA ACCEPTANCE LETTER

146479
Knobbe, Martens, Olson & Bear, LLP
2040 Main Street
Fourteenth Floor
Irvine, CA 92614



Date Mailed: 05/22/2017

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 05/18/2017.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

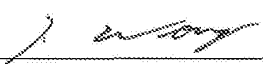
/sleutchit/

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	62/289,085
Filing Date	January 29, 2016
First Named Inventor	Stephen Vincent Mangiat
Title	HEAD POSE MIXING OF AUDIO FILES
Art Unit	Unassigned
Examiner Name	Unassigned
Attorney Docket Number	MLEAP.012PR2

SIGNATURE of Applicant or Patent Practitioner

Signature		Date (Optional)	
Name	Zi Y. Wong	Registration Number	58,410
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			
NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.			
☒ *Total of <u>1</u> forms are submitted.			

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

146479

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

Firm or Individual Name				
Address				
City	State	Zip		
Country				
Telephone	Email			

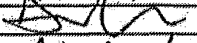
I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Magic Leap, Inc.

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature		Date (Optional)	2-23-17
Name	DAVID LUNDMARK		
Title	CHIEF PATENT COUNSEL		

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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

Electronic Acknowledgement Receipt	
EFS ID:	29247272
Application Number:	62289085
International Application Number:	
Confirmation Number:	1043
Title of Invention:	HEAD POSE MIXING OF AUDIO FILES
First Named Inventor/Applicant Name:	Stephen V. Mangiat
Customer Number:	20995
Filer:	Zi Y. Wong/Sandra Autry
Filer Authorized By:	Zi Y. Wong
Attorney Docket Number:	MLEAP.012PR2
Receipt Date:	18-MAY-2017
Filing Date:	29-JAN-2016
Time Stamp:	13:51:26
Application Type:	Provisional

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	Power of Attorney	MLEAP_012PR2-POA.pdf	1244155	no	2
			47e96f271dc9024cc9d9fc72a51ceb7892238148		
Warnings:					

Information:	
Total Files Size (in bytes):	1244155
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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Alexandria, Virginia 22313-1450
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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
62/289,085	01/29/2016		260	MLEAP.012PR2		

CONFIRMATION NO. 1043
FILING RECEIPT



CC000000080923694

20995
KNOBBE MARTENS OLSON & BEAR LLP
2040 MAIN STREET
FOURTEENTH FLOOR
IRVINE, CA 92614

Date Mailed: 02/26/2016

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, 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 Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections 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**

Inventor(s)

Stephen V. Mangiat, San Francisco, CA;

Applicant(s)

Magic Leap, Inc., Dania Beach, FL;

Power of Attorney:

Andrew Quecan--68516

Permission to Access Application via Priority Document Exchange: Yes**Permission to Access Search Results:** Yes

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: 02/25/2016

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/289,085**

Projected Publication Date: None, application is not eligible for pre-grant publication**Non-Publication Request:** No**Early Publication Request:** No**Title**

HEAD POSE MIXING OF AUDIO FILES

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

page 1 of 3

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 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.

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor	1				Remove
Legal Name					
Prefix	Given Name	Middle Name	Family Name	Suffix	
	Stephen	V.	Mangiat		
Residence Information (Select One) • ☒ US Residency ☐ Non US Residency ☐ Active US Military Service					
City	San Francisco	State/Province	CA	Country of Residence	US
Mailing Address of Inventor:					
Address 1	1855 Griffin Road, Suite B454				
Address 2					
City	Dania Beach	State/Province	FL		
Postal Code	33004	Country i	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button. Add					

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
☐ An Address is being provided for the correspondence information of this application.			
Customer Number	20995		
Email Address	efiling@knobbe.com	Add Email	Remove Email

Application Information:

Title of the Invention	HEAD POSE MIXING OF AUDIO FILES		
Attorney Docket Number	MLEAP.012PR2	Small Entity Status Claimed	☐
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	9	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		

Filing By Reference:

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

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

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

Publication Information:

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

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

Representative Information:

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

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	20995		

Domestic Benefit/National Stage Information:

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

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

Prior Application Status		Remove	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		

Foreign Priority Information:

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

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

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

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

☐ NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		

Authorization or Opt-Out of Authorization to Permit Access:

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

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

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

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

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

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

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

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

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

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

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant	1		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
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor:			
If the Applicant is an Organization check here. ☒			
Organization Name	Magic Leap, Inc.		
Mailing Address Information For Applicant:			
Address 1	1855 Griffin Road, Suite B454		
Address 2			
City	Dania Beach	State/Province	FL
Country	US	Postal Code	33004
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button. Add			

Assignee Information including Non-Applicant Assignee Information:

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

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		

Assignee	1			
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
				Remove
If the Assignee or Non-Applicant Assignee is an Organization check here. ☐				
Prefix	Given Name	Middle Name	Family Name	Suffix
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1				
Address 2				
City		State/Province		
Country ⁱ		Postal Code		
Phone Number		Fax Number		
Email Address				
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.				Add

Signature:

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

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First Name	Andrew	Last Name	Quecan	Registration Number
			68516	
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	MLEAP.012PR2
		Application Number	
Title of Invention	HEAD POSE MIXING OF AUDIO FILES		

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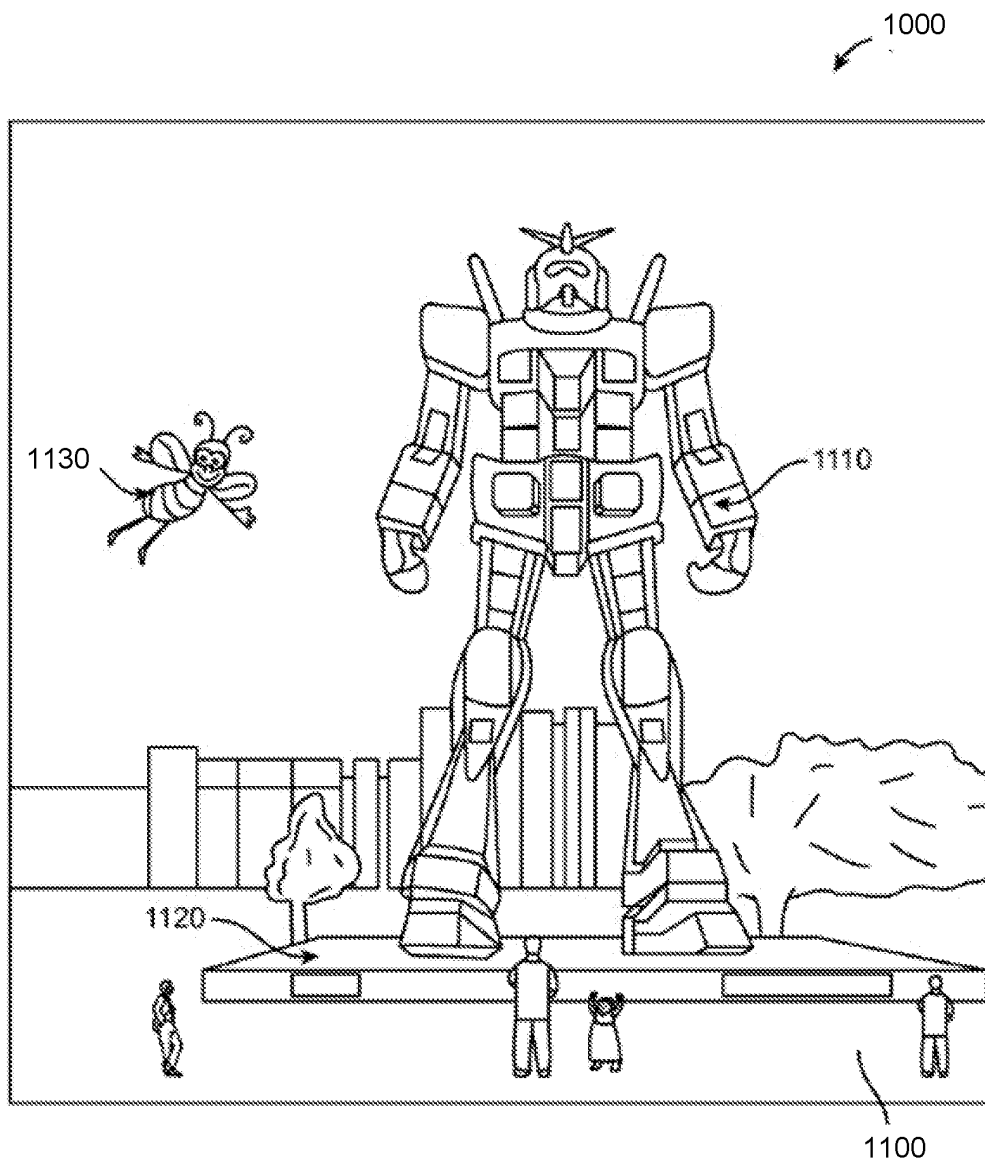


FIG. 1

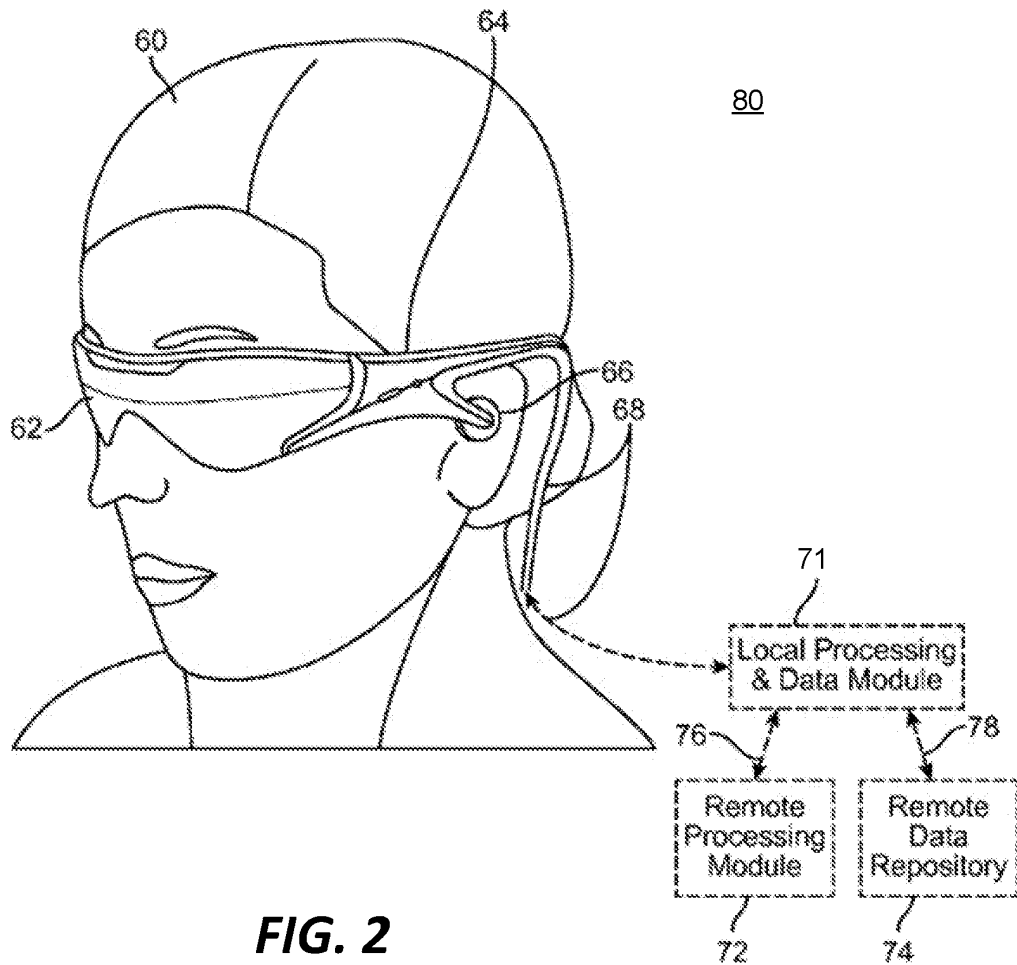


FIG. 2

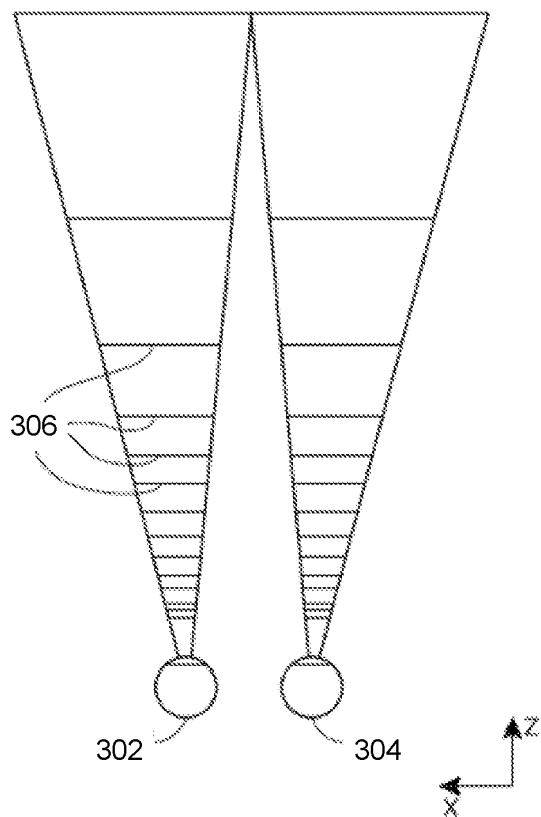


FIG. 3

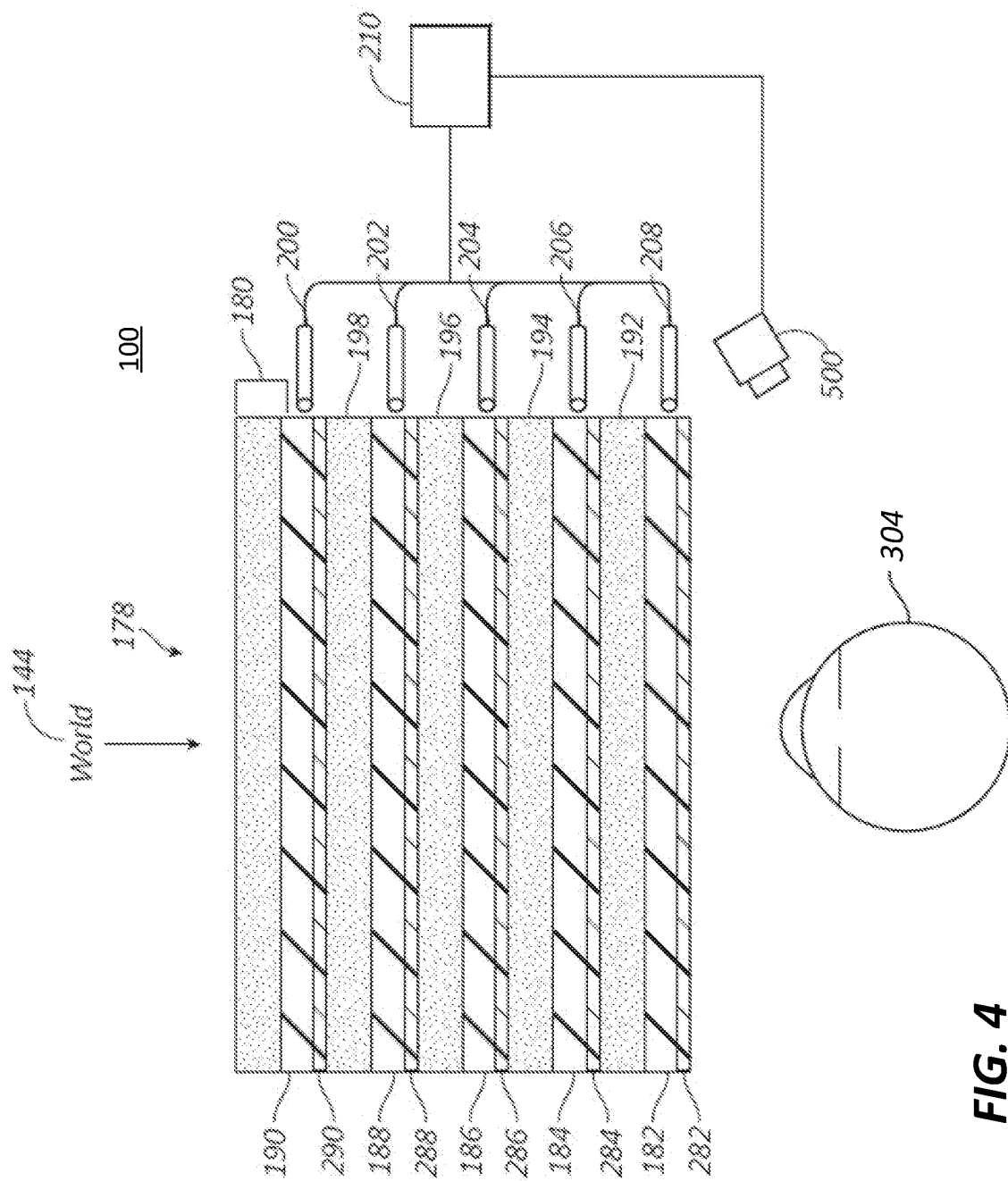


FIG. 4

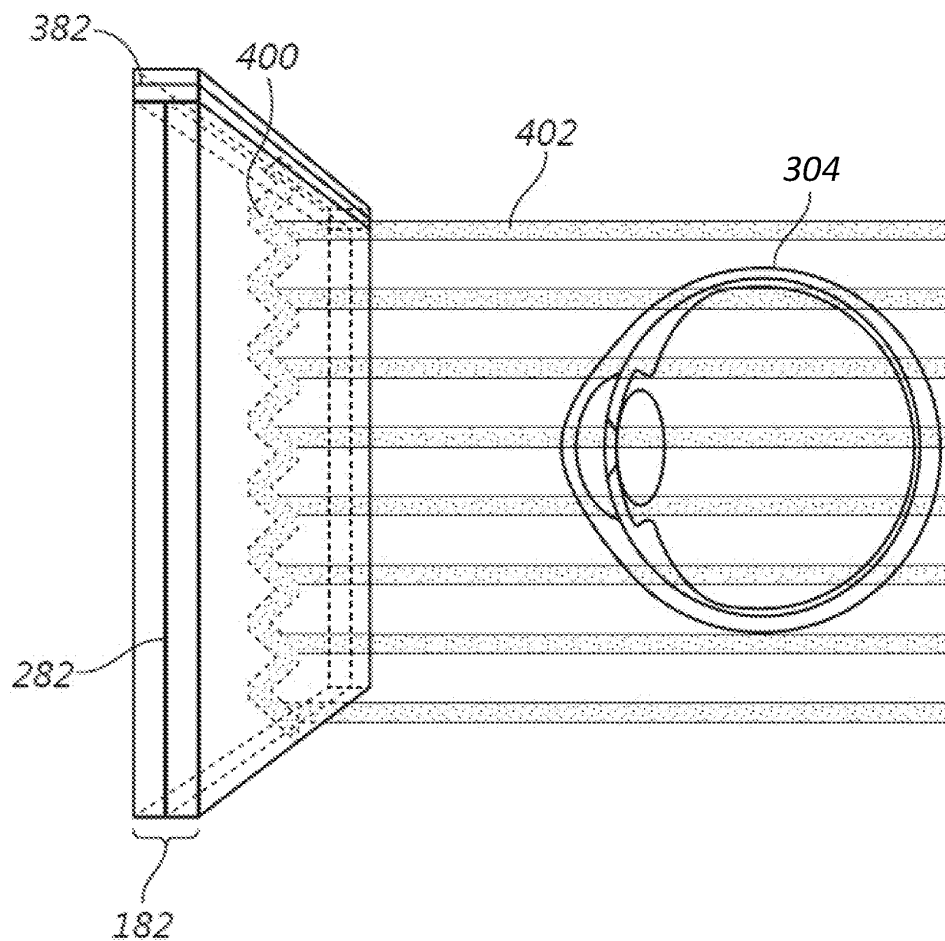


FIG. 5

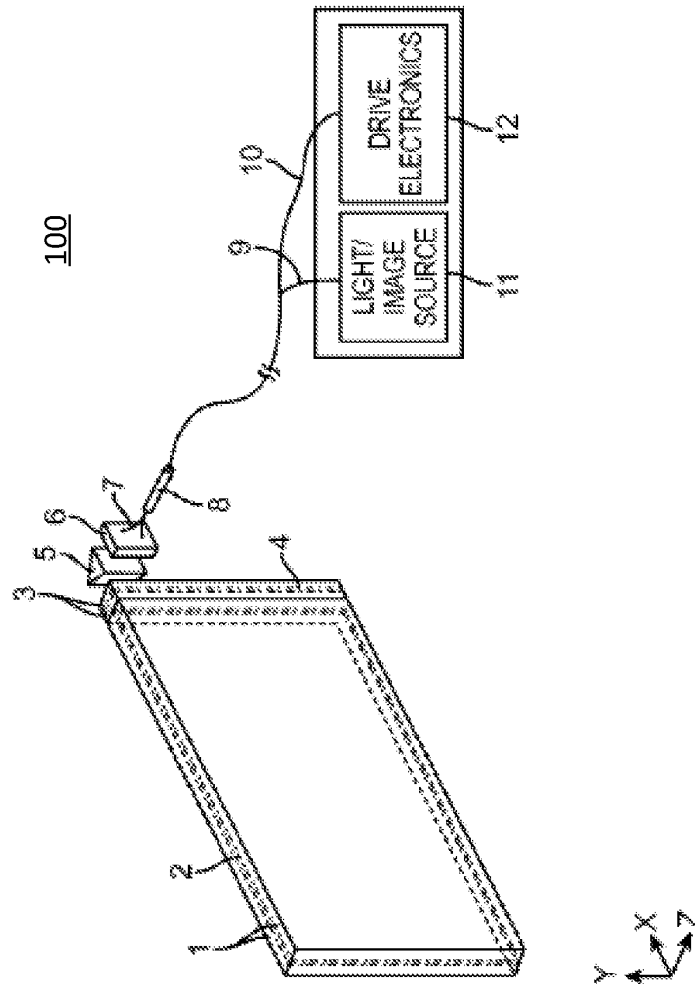


FIG. 6

700

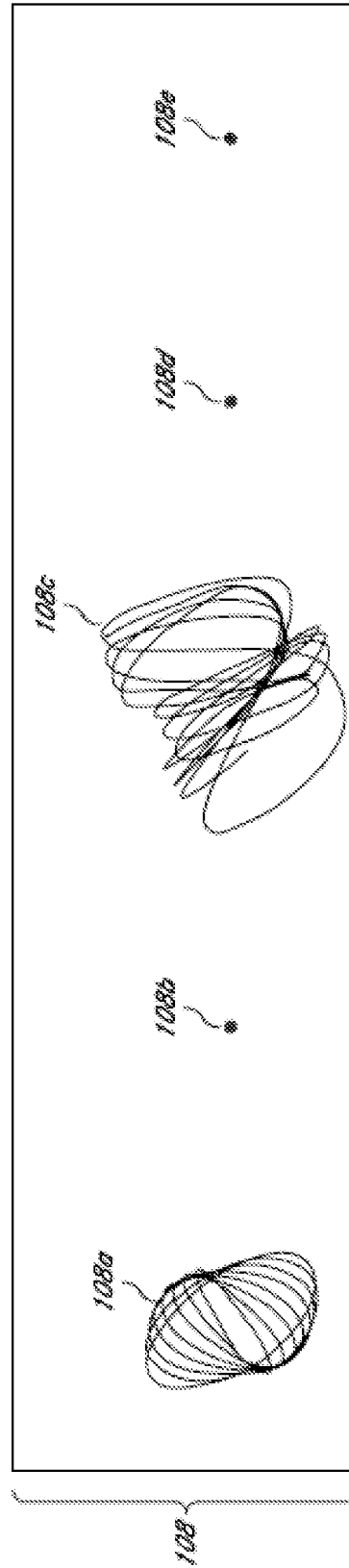
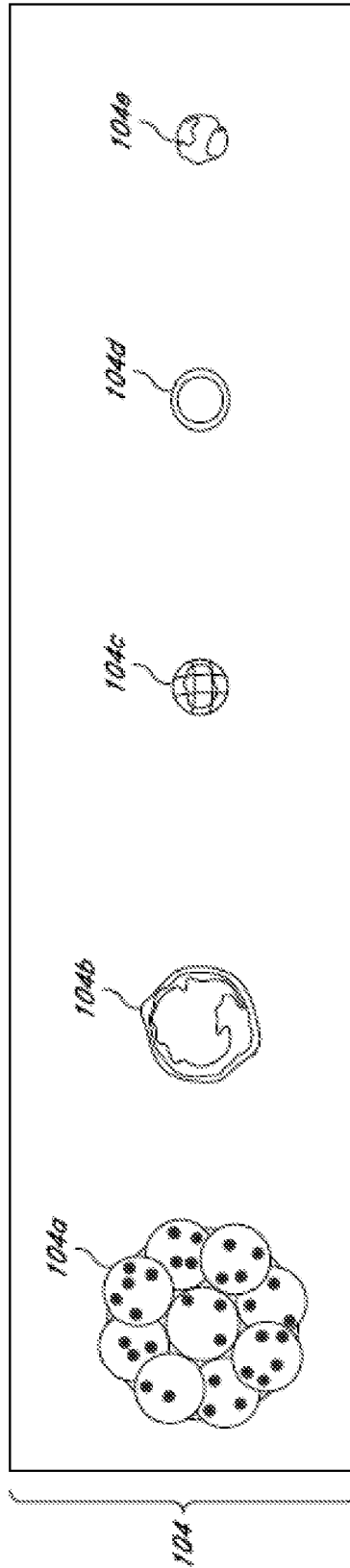


FIG. 7A

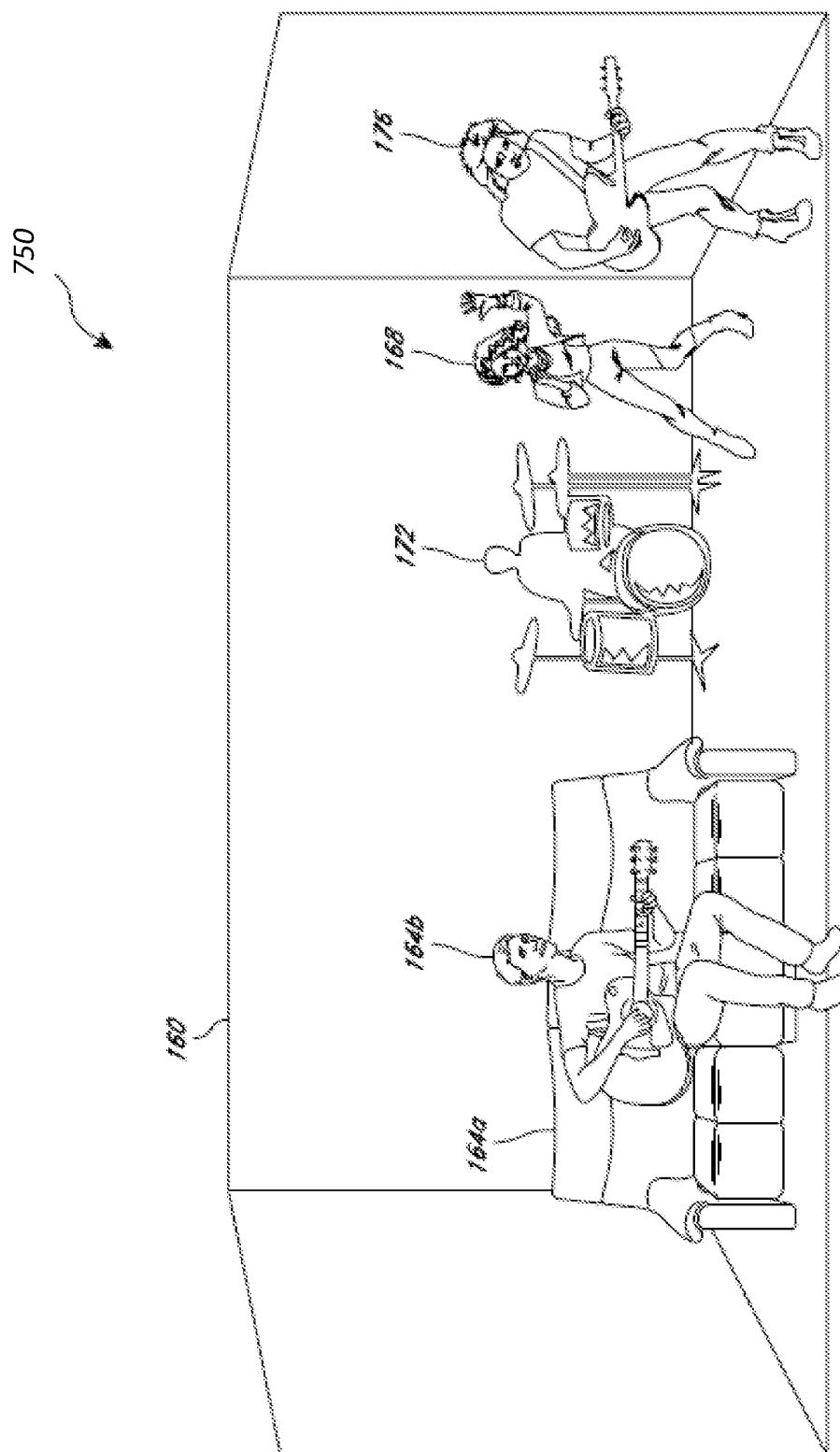


FIG. 7B

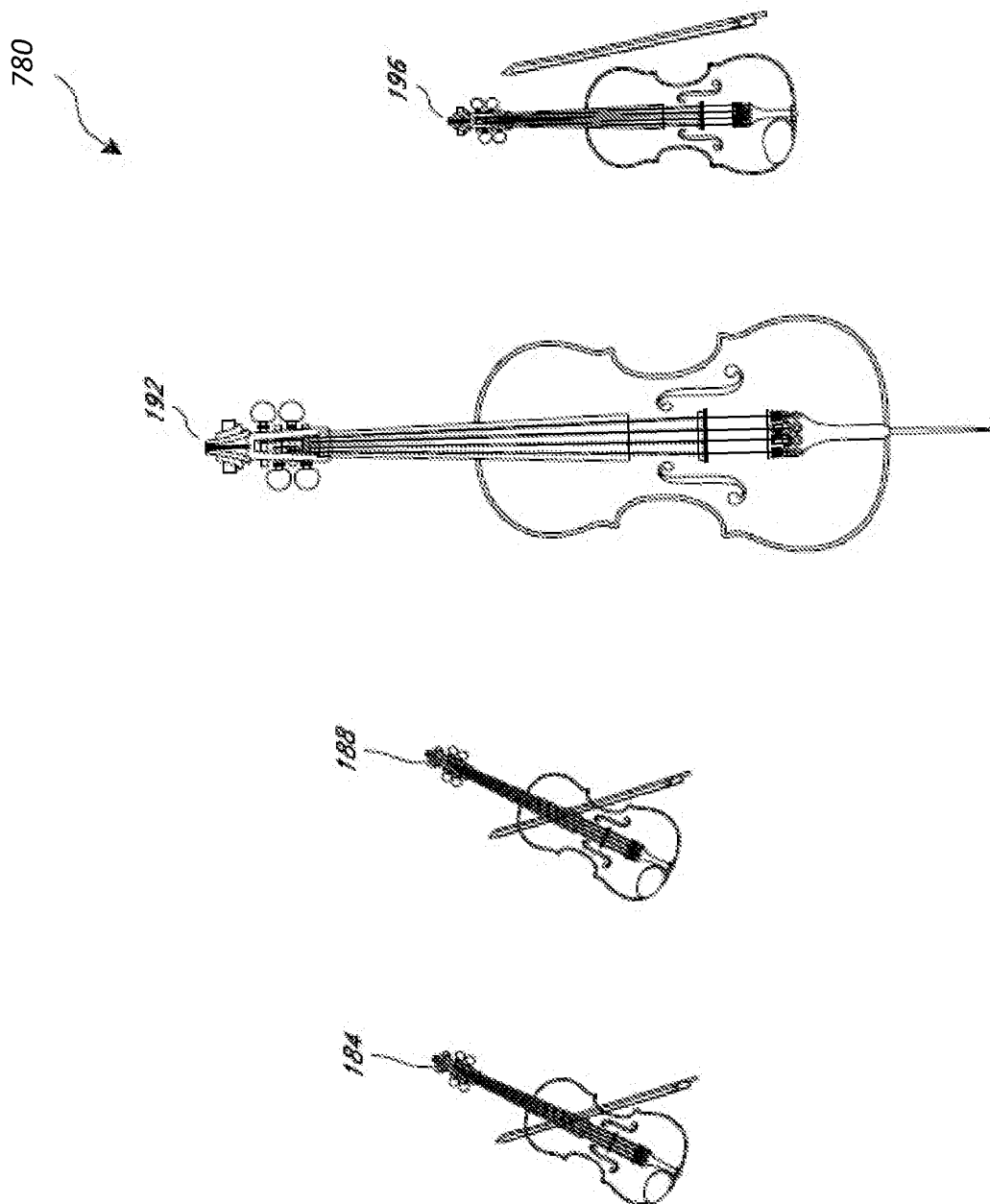


FIG. 7C

HEAD POSE MIXING OF AUDIO FILES

FIELD

[0001] The present disclosure relates to virtual reality and augmented reality imaging and visualization systems and in particular to systems for mixing audio files based on eye pose or head pose.

BACKGROUND

[0002] Modern computing and display technologies have facilitated the development of systems for so called "virtual reality" or "augmented reality" experiences, wherein digitally reproduced images or portions thereof are presented to a user in a manner wherein they seem to be, or may be perceived as, real. A virtual reality, or "VR", scenario typically involves presentation of digital or virtual image information without transparency to other actual real-world visual input; an augmented reality, or "AR", scenario typically involves presentation of digital or virtual image information as an augmentation to visualization of the actual world around the user. For example, referring to FIG. 1, an augmented reality scene 1000 is depicted wherein a user of an AR technology sees a real-world park-like setting 1100 featuring people, trees, buildings in the background, and a concrete platform 1120. In addition to these items, the user of the AR technology also perceives that he "sees" a robot statue 1110 standing upon the real-world platform 1120, and a cartoon-like avatar character 1130 flying by which seems to be a personification of a bumble bee, even though these elements do not exist in the real world. As it turns out, the human visual perception system is very complex, and producing a VR or AR technology that facilitates a comfortable, natural-feeling, rich presentation of virtual image elements amongst other virtual or real-world imagery elements is challenging. Systems and methods disclosed herein address various challenges related to VR and AR technology.

SUMMARY

[0003] Examples of wearable display devices that can present to a wearer of the display device an audible or visual representation of an audio file comprising a plurality of stem tracks that represent different audio content of the audio file are described.

[0004] An embodiment of a wearable display device comprises non-transitory memory configured to store an audio file comprising a plurality of stem tracks, with each stem track representing different audio content of the audio file; a sensor configured to measure information associated with a pose of the wearer of the wearable display device; a display configured to present images to an eye of the wearer of the wearable display device; a speaker configured to present sounds to the wearer of the wearable display device; and a processor in communication with the non-transitory memory, the sensor, the speaker, and the display. The processor is programmed with executable instructions to: determine the pose of the wearer; generate, based at least partly on the pose of the wearer, an audio mix of at least one of the plurality of stem tracks of the audio file; generate, based at least partly on the pose of the wearer and the audio mix, a visualization of the audio mix; communicate an audio signal representative of the audio mix to the speaker; and communicate a visual signal representative of the visualization of the audio mix to the display.

[0005] In another aspect, a method for interacting with an augmented reality object is described. The method is performed under control of a hardware computer processor. The method comprises generating an augmented reality object for interaction by a wearer of the wearable display system; detecting gestures of a wearer while the wearer interacts with the interface; associating the detected gestures with a modification to a characteristic of the augmented reality object; and modifying the augmented reality object in accordance with the modification to the characteristic of the augmented reality object. A wearable display system can include a processor that performs the method for interacting with the augmented reality object.

[0006] Details of one or more implementations of the subject matter described in this specification are set forth in the accompanying drawings and the description below. Other features, aspects, and advantages will become apparent from the description, the drawings, and the claims. Neither this summary nor the following detailed description purports to define or limit the scope of the inventive subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 depicts an illustration of an augmented reality scenario with certain virtual reality objects, and certain actual reality objects viewed by a person.

[0008] FIG. 2 schematically illustrates an example of a wearable display system.

[0009] FIG. 3 schematically illustrates aspects of an approach for simulating three-dimensional imagery using multiple depth planes.

[0010] FIG. 4 schematically illustrates an example of a waveguide stack for outputting image information to a user.

[0011] FIG. 5 shows example exit beams that may be outputted by a waveguide.

[0012] FIG. 6 is a schematic diagram showing an optical system including a waveguide apparatus, an optical coupler subsystem to optically couple light to or from the waveguide apparatus, and a control subsystem, used in the generation of a multi-focal volumetric display, image, or light field.

[0013] FIGS. 7A-7C schematically illustrate examples of views that can be displayed to a wearer of a wearable display system as an audio file having multiple stem tracks is dynamically mixed based at least in part on the wearer's head pose or eye pose.

[0014] Throughout the drawings, reference numbers may be re-used to indicate correspondence between referenced elements. The drawings are provided to illustrate example embodiments described herein and are not intended to limit the scope of the disclosure.

DETAILED DESCRIPTION

Overview

[0015] In order for a three-dimensional (3-D) display to produce a true sensation of depth, and more specifically, a simulated sensation of surface depth, it is desirable for each point in the display's visual field to generate the accommodative response corresponding to its virtual depth. If the accommodative response to a display point does not correspond to the virtual depth of that point, as determined by the binocular depth cues of convergence and stereopsis, the human eye may experience an accommodation conflict,

resulting in unstable imaging, harmful eye strain, headaches, and, in the absence of accommodation information, almost a complete lack of surface depth.

[0016] VR and AR experiences can be provided by display systems having displays in which images corresponding to a plurality of depth planes are provided to a viewer. The images may be different for each depth plane (e.g., provide slightly different presentations of a scene or object) and may be separately focused by the viewer's eyes, thereby helping to provide the user with depth cues based on the accommodation of the eye required to bring into focus different image features for the scene located on different depth plane and/or based on observing different image features on different depth planes being out of focus. As discussed elsewhere herein, such depth cues provide credible perceptions of depth.

[0017] FIG. 2 illustrates an example of wearable display system 80. The display system 80 includes a display 62, and various mechanical and electronic modules and systems to support the functioning of display 62. The display 62 may be coupled to a frame 64, which is wearable by a display system user, wearer, or viewer 60 and which is configured to position the display 62 in front of the eyes of the user 60. In some embodiments, a speaker 66 is coupled to the frame 64 and positioned adjacent the ear canal of the user (in some embodiments, another speaker, not shown, is positioned adjacent the other ear canal of the user to provide for stereo/shapeable sound control). The display 62 is operatively coupled 68, such as by a wired lead or wireless connectivity, to a local data processing module 71 which may be mounted in a variety of configurations, such as fixedly attached to the frame 64, fixedly attached to a helmet or hat worn by the user, embedded in headphones, or otherwise removably attached to the user 60 (e.g., in a backpack-style configuration, in a belt-coupling style configuration).

[0018] The local processing and data module 71 may comprise a hardware processor, as well as digital memory, such as non-volatile memory (e.g., flash memory), both of which may be utilized to assist in the processing, caching, and storage of data. The data may include data a) captured from sensors (which may be, e.g., operatively coupled to the frame 64 or otherwise attached to the user 60), such as image capture devices (e.g., cameras), microphones, inertial measurement units (IMUs), accelerometers, compasses, global positioning system (GPS) units, radio devices, and/or gyroscopes; and/or b) acquired and/or

processed using remote processing module 72 and/or remote data repository 74, possibly for passage to the display 62 after such processing or retrieval. The local processing and data module 71 may be operatively coupled by communication links 76 and/or 78, such as via wired or wireless communication links, to the remote processing module 72 and/or remote data repository 74 such that these remote modules are available as resources to the local processing and data module (71). In addition, remote processing module 72 and remote data repository 74 may be operatively coupled to each other.

[0019] In some embodiments, the remote processing module 72 may comprise one or more processors configured to analyze and process data and/or image information. In some embodiments, the remote data repository 74 may comprise a digital data storage facility, which may be available through the internet or other networking configuration in a “cloud” resource configuration. In some embodiments, all data is stored and all computations are performed in the local processing and data module, allowing fully autonomous use from a remote module.

[0020] The human visual system is complicated and providing a realistic perception of depth is challenging. Without being limited by theory, it is believed that viewers of an object may perceive the object as being three-dimensional due to a combination of vergence and accommodation. Vergence movements (i.e., rolling movements of the pupils toward or away from each other to converge the lines of sight of the eyes to fixate upon an object) of the two eyes relative to each other are closely associated with focusing (or “accommodation”) of the lenses of the eyes. Under normal conditions, changing the focus of the lenses of the eyes, or accommodating the eyes, to change focus from one object to another object at a different distance will automatically cause a matching change in vergence to the same distance, under a relationship known as the “accommodation-vergence reflex.” Likewise, a change in vergence will trigger a matching change in accommodation, under normal conditions. Display systems that provide a better match between accommodation and vergence may form more realistic and comfortable simulations of three-dimensional imagery.

[0021] FIG. 3 illustrates aspects of an approach for simulating three-dimensional imagery using multiple depth planes. With reference to FIG. 3, objects at various distances from eyes 302 and 304 on the z-axis are accommodated by the eyes 302 and 304 so that

those objects are in focus. The eyes 302 and 304 assume particular accommodated states to bring into focus objects at different distances along the z-axis. Consequently, a particular accommodated state may be said to be associated with a particular one of depth planes 306, with has an associated focal distance, such that objects or parts of objects in a particular depth plane are in focus when the eye is in the accommodated state for that depth plane. In some embodiments, three-dimensional imagery may be simulated by providing different presentations of an image for each of the eyes 302 and 304, and also by providing different presentations of the image corresponding to each of the depth planes. While shown as being separate for clarity of illustration, it will be appreciated that the fields of view of the eyes 302 and 304 may overlap, for example, as distance along the z-axis increases. In addition, while shown as flat for ease of illustration, it will be appreciated that the contours of a depth plane may be curved in physical space, such that all features in a depth plane are in focus with the eye in a particular accommodated state. Without being limited by theory, it is believed that the human eye typically can interpret a finite number of depth planes to provide depth perception. Consequently, a highly believable simulation of perceived depth may be achieved by providing, to the eye, different presentations of an image corresponding to each of these limited number of depth planes.

Waveguide Stack Assembly

[0022] FIG. 4 illustrates an example of a waveguide stack for outputting image information to a user. A display system 100 includes a stack of waveguides, or stacked waveguide assembly 178 that may be utilized to provide three-dimensional perception to the eye/brain using a plurality of waveguides 182, 184, 186, 188, 190. In some embodiments, the display system 100 may correspond to system 80 of FIG. 2, with FIG. 4 schematically showing some parts of that system 80 in greater detail. For example, in some embodiments, the waveguide assembly 178 may be integrated into the display 62 of FIG. 2.

[0023] With continued reference to FIG. 4, the waveguide assembly 178 may also include a plurality of features 198, 196, 194, 192 between the waveguides. In some embodiments, the features 198, 196, 194, 192 may be lenses. The waveguides 182, 184, 186, 188, 190 and/or the plurality of lenses 198, 196, 194, 192 may be configured to send image information to the eye with various levels of wavefront curvature or light ray divergence.

Each waveguide level may be associated with a particular depth plane and may be configured to output image information corresponding to that depth plane. Image injection devices 200, 202, 204, 206, 208 may be utilized to inject image information into the waveguides 182, 184, 186, 188, 190, each of which may be configured to distribute incoming light across each respective waveguide, for output toward the eye 304. Light exits an output surface of the image injection devices 200, 202, 204, 206, 208 and is injected into a corresponding input edge of the waveguides 182, 184, 186, 188, 190. In some embodiments, a single beam of light (e.g., a collimated beam) may be injected into each waveguide to output an entire field of cloned collimated beams that are directed toward the eye 304 at particular angles (and amounts of divergence) corresponding to the depth plane associated with a particular waveguide.

[0024] In some embodiments, the image injection devices 200, 202, 204, 206, 208 are discrete displays that each produce image information for injection into a corresponding waveguide 182, 184, 186, 188, 190, respectively. In some other embodiments, the image injection devices 200, 202, 204, 206, 208 are the output ends of a single multiplexed display which may, e.g., pipe image information via one or more optical conduits (such as fiber optic cables) to each of the image injection devices 200, 202, 204, 206, 208.

[0025] A controller 210 controls the operation of the stacked waveguide assembly 178 and the image injection devices 200, 202, 204, 206, 208. In some embodiments, the controller 210 includes programming (e.g., instructions in a non-transitory computer-readable medium) that regulates the timing and provision of image information to the waveguides 182, 184, 186, 188, 190. In some embodiments, the controller may be a single integral device, or a distributed system connected by wired or wireless communication channels. The controller 210 may be part of the processing modules 71 or 72 (illustrated in FIG. 2) in some embodiments.

[0026] The waveguides 182, 184, 186, 188, 190 may be configured to propagate light within each respective waveguide by total internal reflection (TIR). The waveguides 182, 184, 186, 188, 190 may each be planar or have another shape (e.g., curved), with major top and bottom surfaces and edges extending between those major top and bottom surfaces. In the illustrated configuration, the waveguides 182, 184, 186, 188, 190 may each include light extracting optical elements 282, 284, 286, 288, 290 that are configured to extract light

out of a waveguide by redirecting the light, propagating within each respective waveguide, out of the waveguide to output image information to the eye 304. Extracted light may also be referred to as outcoupled light, and light extracting optical elements may also be referred to as outcoupling optical elements. An extracted beam of light is outputted by the waveguide at locations at which the light propagating in the waveguide strikes a light redirecting element. The light extracting optical elements (82, 284, 286, 288, 290 may, for example, be reflective and/or diffractive optical features. While illustrated disposed at the bottom major surfaces of the waveguides 182, 184, 186, 188, 190 for ease of description and drawing clarity, in some embodiments, the light extracting optical elements 282, 284, 286, 288, 290 may be disposed at the top and/or bottom major surfaces, and/or may be disposed directly in the volume of the waveguides 182, 184, 186, 188, 190. In some embodiments, the light extracting optical elements 282, 284, 286, 288, 290 may be formed in a layer of material that is attached to a transparent substrate to form the waveguides 182, 184, 186, 188, 190. In some other embodiments, the waveguides 182, 184, 186, 188, 190 may be a monolithic piece of material and the light extracting optical elements 282, 284, 286, 288, 290 may be formed on a surface and/or in the interior of that piece of material.

[0027] With continued reference to FIG. 4, as discussed herein, each waveguide 182, 184, 186, 188, 190 is configured to output light to form an image corresponding to a particular depth plane. For example, the waveguide 182 nearest the eye may be configured to deliver collimated light, as injected into such waveguide 182, to the eye 304. The collimated light may be representative of the optical infinity focal plane. The next waveguide up 184 may be configured to send out collimated light which passes through the first lens 192 (e.g., a negative lens) before it can reach the eye 304. First lens 192 may be configured to create a slight convex wavefront curvature so that the eye/brain interprets light coming from that next waveguide up 184 as coming from a first focal plane closer inward toward the eye 304 from optical infinity. Similarly, the third up waveguide 186 passes its output light through both the first lens 192 and second lens 194 before reaching the eye 304. The combined optical power of the first and second lenses 192 and 194 may be configured to create another incremental amount of wavefront curvature so that the eye/brain interprets light coming from the third waveguide 186 as coming from a second focal plane that is even closer inward toward the person from optical infinity than was light from the next waveguide up 184.

[0028] The other waveguide layers (e.g., waveguides 188, 190) and lenses (e.g., lenses 196, 198) are similarly configured, with the highest waveguide 190 in the stack sending its output through all of the lenses between it and the eye for an aggregate focal power representative of the closest focal plane to the person. To compensate for the stack of lenses 198, 196, 194, 192 when viewing/interpreting light coming from the world 144 on the other side of the stacked waveguide assembly 178, a compensating lens layer 180 may be disposed at the top of the stack to compensate for the aggregate power of the lens stack 198, 196, 194, 192 below. Such a configuration provides as many perceived focal planes as there are available waveguide/lens pairings. Both the light extracting optical elements of the waveguides and the focusing aspects of the lenses may be static (e.g., not dynamic or electro-active). In some alternative embodiments, either or both may be dynamic using electro-active features.

[0029] With continued reference to FIG. 4, the light extracting optical elements 282, 284, 286, 288, 290 may be configured to both redirect light out of their respective waveguides and to output this light with the appropriate amount of divergence or collimation for a particular depth plane associated with the waveguide. As a result, waveguides having different associated depth planes may have different configurations of light extracting optical elements, which output light with a different amount of divergence depending on the associated depth plane. In some embodiments, as discussed herein, the light extracting optical elements 282, 284, 286, 288, 290 may be volumetric or surface features, which may be configured to output light at specific angles. For example, the light extracting optical elements 282, 284, 286, 288, 290 may be volume holograms, surface holograms, and/or diffraction gratings. Light extracting optical elements, such as diffraction gratings, are described in U.S. Patent Publication No. 2015/0178939, published June 25, 2015, which is incorporated by reference herein in its entirety. In some embodiments, the features 198, 196, 194, 192 may not be lenses. Rather, they may simply be spacers (e.g., cladding layers and/or structures for forming air gaps).

[0030] In some embodiments, the light extracting optical elements 282, 284, 286, 288, 290 are diffractive features that form a diffraction pattern, or “diffractive optical element” (also referred to herein as a “DOE”). Preferably, the DOE’s have a relatively low diffraction efficiency so that only a portion of the light of the beam is deflected away toward

the eye 304 with each intersection of the DOE, while the rest continues to move through a waveguide via total internal reflection. The light carrying the image information is thus divided into a number of related exit beams that exit the waveguide at a multiplicity of locations and the result is a fairly uniform pattern of exit emission toward the eye 304 for this particular collimated beam bouncing around within a waveguide.

[0031] In some embodiments, one or more DOEs may be switchable between “on” states in which they actively diffract, and “off” states in which they do not significantly diffract. For instance, a switchable DOE may comprise a layer of polymer dispersed liquid crystal, in which microdroplets comprise a diffraction pattern in a host medium, and the refractive index of the microdroplets can be switched to substantially match the refractive index of the host material (in which case the pattern does not appreciably diffract incident light) or the microdroplet can be switched to an index that does not match that of the host medium (in which case the pattern actively diffracts incident light).

[0032] In some embodiments, the number and distribution of depth planes and/or depth of field may be varied dynamically based on the pupil sizes and/or orientations of the eyes of the viewer. In some embodiments, a camera 500 (e.g., a digital camera) may be used to capture images of the eye 304 to determine the size and/or orientation of the pupil of the eye 304. The camera 500 can be used to obtain images for use in determining the direction the wearer 60 is looking (e.g., eye pose). In some embodiments, the camera 500 may be attached to the frame 64 (as illustrated in FIG. 2) and may be in electrical communication with the processing modules 71 and/or 72, which may process image information from the camera 500 to determine, e.g., the pupil diameters and/or orientations of the eyes or eye pose of the user 60. In some embodiments, one camera 500 may be utilized for each eye, to separately determine the pupil size and/or orientation of each eye, thereby allowing the presentation of image information to each eye to be dynamically tailored to that eye. In some other embodiments, the pupil diameter and/or orientation of only a single eye 304 (e.g., using only a single camera 500 per pair of eyes) is determined and assumed to be similar for both eyes of the viewer 60.

[0033] For example, depth of field may change inversely with a viewer’s pupil size. As a result, as the sizes of the pupils of the viewer’s eyes decrease, the depth of field increases such that one plane not discernible because the location of that plane is beyond the

depth of focus of the eye may become discernible and appear more in focus with reduction of pupil size and commensurate increase in depth of field. Likewise, the number of spaced apart depth planes used to present different images to the viewer may be decreased with decreased pupil size. For example, a viewer may not be able to clearly perceive the details of both a first depth plane and a second depth plane at one pupil size without adjusting the accommodation of the eye away from one depth plane and to the other depth plane. These two depth planes may, however, be sufficiently in focus at the same time to the user at another pupil size without changing accommodation.

[0034] In some embodiments, the display system may vary the number of waveguides receiving image information based upon determinations of pupil size and/or orientation, or upon receiving electrical signals indicative of particular pupil sizes and/or orientations. For example, if the user's eyes are unable to distinguish between two depth planes associated with two waveguides, then the controller 210 may be configured or programmed to cease providing image information to one of these waveguides. Advantageously, this may reduce the processing burden on the system, thereby increasing the responsiveness of the system. In embodiments in which the DOEs for a waveguide are switchable between on and off states, the DOEs may be switched to the off state when the waveguide does receive image information.

[0035] In some embodiments, it may be desirable to have an exit beam meet the condition of having a diameter that is less than the diameter of the eye of a viewer. However, meeting this condition may be challenging in view of the variability in size of the viewer's pupils. In some embodiments, this condition is met over a wide range of pupil sizes by varying the size of the exit beam in response to determinations of the size of the viewer's pupil. For example, as the pupil size decreases, the size of the exit beam may also decrease. In some embodiments, the exit beam size may be varied using a variable aperture.

[0036] FIG. 5 shows an example of exit beams outputted by a waveguide. One waveguide is illustrated, but it will be appreciated that other waveguides in the waveguide assembly 178 may function similarly, where the waveguide assembly 178 includes multiple waveguides. Light 400 is injected into the waveguide 182 at the input edge 382 of the waveguide 182 and propagates within the waveguide 182 by TIR. At points where the light 400 impinges on the DOE 282, a portion of the light exits the waveguide as exit beams 402.

The exit beams 402 are illustrated as substantially parallel but they may also be redirected to propagate to the eye 304 at an angle (e.g., forming divergent exit beams), depending on the depth plane associated with the waveguide 182. It will be appreciated that substantially parallel exit beams may be indicative of a waveguide with light extracting optical elements that outcouple light to form images that appear to be set on a depth plane at a large distance (e.g., optical infinity) from the eye 304. Other waveguides or other sets of light extracting optical elements may output an exit beam pattern that is more divergent, which would require the eye 304 to accommodate to a closer distance to bring it into focus on the retina and would be interpreted by the brain as light from a distance closer to the eye 304 than optical infinity.

[0037] FIG. 6 shows another example of the optical display system 100 including a waveguide apparatus, an optical coupler subsystem to optically couple light to or from the waveguide apparatus, and a control subsystem. The optical system 100 can be used to generate a multi-focal volumetric, image, or light field. The optical system can include one or more primary planar waveguides 1 (only one is shown in FIG. 6) and one or more DOEs 2 associated with each of at least some of the primary waveguides 10. The planar waveguides 1 can be similar to the waveguides 182, 184, 186, 188, 190 discussed with reference to FIG. 4. The optical system may employ a distribution waveguide apparatus, to relay light along a first axis (vertical or Y-axis in view of FIG. 6), and expand the light's effective exit pupil along the first axis (e.g., Y-axis). The distribution waveguide apparatus, may, for example include a distribution planar waveguide 3 and at least one DOE 4 (illustrated by double dash-dot line) associated with the distribution planar waveguide 3. The distribution planar waveguide 3 may be similar or identical in at least some respects to the primary planar waveguide 1, having a different orientation therefrom. Likewise, the at least one DOE 4 may be similar or identical in at least some respects to the DOE 2. For example, the distribution planar waveguide 3 and/or DOE 4 may be comprised of the same materials as the primary planar waveguide 1 and/or DOE 2, respectively. The optical system shown in FIG. 6 can be integrated into the wearable display system 80 shown in FIG. 2.

[0038] The relayed and exit-pupil expanded light is optically coupled from the distribution waveguide apparatus into the one or more primary planar waveguides 10. The primary planar waveguide 1 relays light along a second axis, preferably orthogonal to first axis, (e.g., horizontal or X-axis in view of FIG. 6). Notably, the second axis can be a non-

orthogonal axis to the first axis. The primary planar waveguide 10 expands the light's effective exit pupil along that second axis (e.g., X-axis). For example, the distribution planar waveguide 3 can relay and expand light along the vertical or Y-axis, and pass that light to the primary planar waveguide 1 which relays and expands light along the horizontal or X-axis.

[0039] The optical system may include one or more sources of colored light (e.g., red, green, and blue laser light) 110 which may be optically coupled into a proximal end of a single mode optical fiber 9. A distal end of the optical fiber 9 may be threaded or received through a hollow tube 8 of piezoelectric material. The distal end protrudes from the tube 8 as fixed-free flexible cantilever 7. The piezoelectric tube 8 can be associated with four quadrant electrodes (not illustrated). The electrodes may, for example, be plated on the outside, outer surface or outer periphery or diameter of the tube 8. A core electrode (not illustrated) is also located in a core, center, inner periphery or inner diameter of the tube 8.

[0040] Drive electronics 12, for example electrically coupled via wires 10, drive opposing pairs of electrodes to bend the piezoelectric tube 8 in two axes independently. The protruding distal tip of the optical fiber 7 has mechanical modes of resonance. The frequencies of resonance can depend upon a diameter, length, and material properties of the optical fiber 7. By vibrating the piezoelectric tube 8 near a first mode of mechanical resonance of the fiber cantilever 7, the fiber cantilever 7 is caused to vibrate, and can sweep through large deflections.

[0041] By stimulating resonant vibration in two axes, the tip of the fiber cantilever 7 is scanned biaxially in an area filling two dimensional (2-D) scan. By modulating an intensity of light source(s) 11 in synchrony with the scan of the fiber cantilever 7, light emerging from the fiber cantilever 7 forms an image. Descriptions of such a set up are provided in U.S. Patent Publication No. 2014/0003762, which is incorporated by reference herein in its entirety.

[0042] A component of an optical coupler subsystem collimates the light emerging from the scanning fiber cantilever 7. The collimated light is reflected by mirrored surface 5 into the narrow distribution planar waveguide 3 which contains the at least one diffractive optical element (DOE) 4. The collimated light propagates vertically (relative to the view of FIG. 6) along the distribution planar waveguide 3 by total internal reflection, and in doing so repeatedly intersects with the DOE 4. The DOE 4 preferably has a low diffraction

efficiency. This causes a fraction (e.g., 10%) of the light to be diffracted toward an edge of the larger primary planar waveguide 1 at each point of intersection with the DOE 4, and a fraction of the light to continue on its original trajectory down the length of the distribution planar waveguide 3 via TIR.

[0043] At each point of intersection with the DOE 4, additional light is diffracted toward the entrance of the primary waveguide 1. By dividing the incoming light into multiple outcoupled sets, the exit pupil of the light is expanded vertically by the DOE 4 in the distribution planar waveguide 3. This vertically expanded light coupled out of distribution planar waveguide 3 enters the edge of the primary planar waveguide 1.

[0044] Light entering primary waveguide 1 propagates horizontally (relative to the view of FIG. 6) along the primary waveguide 1 via TIR. As the light intersects with DOE 2 at multiple points as it propagates horizontally along at least a portion of the length of the primary waveguide 10 via TIR. The DOE 2 may advantageously be designed or configured to have a phase profile that is a summation of a linear diffraction pattern and a radially symmetric diffractive pattern, to produce both deflection and focusing of the light. The DOE 2 may advantageously have a low diffraction efficiency (e.g., 10%), so that only a portion of the light of the beam is deflected toward the eye of the view with each intersection of the DOE 2 while the rest of the light continues to propagate through the waveguide 1 via TIR.

[0045] At each point of intersection between the propagating light and the DOE 2, a fraction of the light is diffracted toward the adjacent face of the primary waveguide 1 allowing the light to escape the TIR, and emerge from the face of the primary waveguide 1. In some embodiments, the radially symmetric diffraction pattern of the DOE 2 additionally imparts a focus level to the diffracted light, both shaping the light wavefront (e.g., imparting a curvature) of the individual beam as well as steering the beam at an angle that matches the designed focus level.

[0046] Accordingly, these different pathways can cause the light to be coupled out of the primary planar waveguide 1 by a multiplicity of DOEs 2 at different angles, focus levels, and/or yielding different fill patterns at the exit pupil. Different fill patterns at the exit pupil can be beneficially used to create a light field display with multiple depth planes. Each layer in the waveguide assembly or a set of layers (e.g., 3 layers) in the stack may be employed to generate a respective color (e.g., red, blue, green). Thus, for example, a first set

of three adjacent layers may be employed to respectively produce red, blue and green light at a first focal depth. A second set of three adjacent layers may be employed to respectively produce red, blue and green light at a second focal depth. Multiple sets may be employed to generate a full 3D or 4D color image light field with various focal depths.

Example Head Pose Mixing of Audio Files

[0047] The eyes of the wearer of a head mounted display (HMD) (e.g., the wearable display system 80 shown in FIG. 2 or the display systems 100 in FIGS. 4 and 6) can be imaged using the camera 500 (see, e.g., FIG. 4) to determine eye pose (e.g., direction of the wearer's eye or eyes). The HMD can also include sensors such as, e.g., accelerometers, gyroscopes, inertial measurement devices, etc., that can be used to determine the orientation of the wearer's head. In some implementations, the processing modules 71 or 72 use data from the camera and/or sensors to determine head pose or eye pose. The HMD can present a light field to the wearer. Accordingly, embodiments of the HMD can utilize the camera and/or the sensors to dynamically determine the wearer's head pose and/or eye pose. In some cases, the term wearer pose will be used to refer to the wearer's head pose, eye pose, or both the head pose and eye pose.

[0048] The data module 71 and/or the remote data repository 74 can store audio files, video files, or both audio and video files. A video file can be associated with an audio file such as a sound track for the video. Audio files can include a plurality of tracks. For example, the audio file can include a stereo master track, tracks for the "right" or "left" channels of a stereo system, tracks for surround sound channels, and so forth. Certain types of audio files can include a plurality of tracks representing different instruments (e.g., guitar, bass, drums, piano, synthesizer, horns) or vocals (e.g., lead vocal, backup vocal). Tracks representing different instruments or vocals are sometimes referred to as stem tracks or stems. In various implementations, the number of stem tracks can be two, three, four, five, six, seven, eight, or more. A stem track can represent a recording of a particular instrument or vocal (e.g., guitar or lead vocal) or a group of instruments or vocals (e.g., a rhythm section of bass and drums or a chorus). For an example of a recording of chamber music (e.g., a string quartet), four separate stem tracks could represent the first violin, the second violin, the viola, and the cello. Stem tracks can represent any partition of an audio recording. For

example, for an orchestra, different stem tracks could represent the violins, the wood winds, the percussion, the brass, the bass, etc. Stem tracks are not limited to musical recordings and can be used for recordings of speech (e.g., different stems for different speakers).

[0049] The combination (or mixing) of the stem files for the different instruments or vocals produces an audio mix that can be presented to a user for playback by the HMD (e.g., via the speaker 66). The mixing can produce one or more audio channels (e.g., stereo or surround sound (which can have 5 or 7 or more channels)), can modify the stem tracks level (e.g., loudness or softness), frequency content, dynamics (e.g., style (staccato or legato), speed), panoramic position (sometimes referred to as panning, e.g., distribution of the musical sounds among the stereo or multi-channel sound field), add effects (e.g., reverb), etc.

[0050] In some implementations, while the wearer is listening to an audio file, the HMD dynamically mixes the stem tracks of an audio file based at least in part on wearer pose. For example, as the wearer's eye(s) or head moves, the HMD (e.g., via the processing modules 71 or 72) can dynamically mix the stem tracks in the audio file to create a "new" set of sounds for presentation to the wearer (e.g., via the speaker 66). Thus, the HMD can advantageously spatialize the mix of the stem tracks of the audio file.

[0051] In some implementations, additionally or alternatively, the HMD (e.g., via the processing modules 71 or 72) can dynamically present images to the wearer (e.g., via the display 62) so that the wearer sees a different visual representation of the audio mix of the stem tracks as the wearer's head or eye(s) pose changes. The HMD can provide a visual mix of the audio stem tracks. Thus, the HMD can advantageously permit the wearer to visualize the audio spatialization of the mix of the stem tracks.

[0052] In effect, every direction (or position) surrounding the wearer can correspond to a different audio or visual mix of the stem tracks and can be perceived by the wearer as a different sound field or visual field. The ability of such embodiments of the display systems disclosed herein to dynamically mix the stem tracks provides a unique, user-controllable user experience.

[0053] Additionally or alternatively, the spatialization or visualization of the mix can be based (at least partly) on gestures by the wearer (e.g., hand movements) or by control signals received from an external device (e.g., mouse or joy stick, controllable by the wearer

or a third party). For example, the HMD can identify a position of the wearer's hands, and as the hands move, the HMD can generate a different mix of the stem tracks for presentation (audibly or visually) to the wearer. In some implementations, the wearer may use his or her hand (or stylus or baton) to "touch" or "move" a real or virtual object seen through the display 62 of the HMD and the HMD may modify or adjust the mix in response to the touch or move.

[0054] In some implementations, the audio file may include the stem tracks as well as information associated with one or more pre-mixed combinations of the stem tracks. In some such implementations, rather than dynamically mixing the stem tracks as the wearer pose changes, the HMD (e.g., the processors 71, 72) may access one of the pre-mixed combinations for presentation (audibly or visually) to the wearer. For example, the pre-mixed combination may reproduce the music as if it were circling around the wearer's head.

[0055] In some implementations, the audio file may include the stem tracks plus additional information that can be used by the HMD to render an audio or visual representation of the music. For example, the additional information may include information relating to movements of musical performers on a stage (e.g., a lead singer moving or dancing around the stage) or information about the acoustics or size of the performance venue (e.g., the size of the stage, the size of the concert hall, etc.). The HMD can use this additional information to present a visual representation of a performance by a musical artist. For example, the movement information for a lead singer can be used to determine where, in the wearer's visual field, a representation (e.g., image or avatar) of the lead singer should be displayed as the lead singer moves around during the performance. Such embodiments can be used to create a visual rendering of a live performance where the audio track was recorded.

[0056] FIGS. 7A-7C schematically illustrate examples of views 700, 750, 780 that can be visually displayed to a wearer of a wearable display system as an audio file having multiple stem tracks is dynamically mixed based at least in part on the wearer's head pose or eye pose. FIG. 7A schematically illustrate two examples 104, 108 for the view 700. In the example views 104 and 108, a mix of five stem tracks is shown. In the example view 104, five different visual graphics (e.g., icons or orbs) 104a – 104e are shown as representing the corresponding five stem tracks. The visual graphics need not be static and can move or

be modified or altered as the audio file is played. In this example, when the wearer's head or eye pose changes, the audio mix changes and the visual representation 104 correspondingly changes. For example, the wearer's eye (or head) pose may indicate the wearer is looking toward the direction of the graphic 104a. In some such cases, the graphic 104a may be displayed as emphasized (e.g., larger, brighter, etc.) than the graphics 104b-104e that are not in the wearer's gaze direction. As the wearer's head or eye pose changes, the wearer will be presented with a different sound field (corresponding to the different audio mix of the stem tracks) and a different visual field.

[0057] FIG. 7A schematically illustrates an alternative example view 108, in which the visual graphics 108a and 108c are presented as Lissajous figures. In this example, the audio tracks corresponding to the stem tracks associated with gaze directions toward points 108b, 108d, and 108e are muted and no (or a greatly reduced in size or brightness) visual graphic is shown in these directions (the points 108b, 108d, and 108e are shown as dots to indicate that no (or a reduced) graphic is displayed to the wearer). The wearer will hear (e.g., through speaker 66) an audio mix of just the stem tracks associated with directions 108a, 108c. In various implementations, the visual graphics 104a-104e, 108a-108e can be different from or the same as each other. Many types of visual graphics can be presented (see, e.g., the examples in FIGS. 7B and 7C), and the examples described herein are intended to be illustrative and not limiting.

[0058] In some implementations, the HMD may use (at least in part) audio spectral (frequency) content of the stem tracks to determine placement of a corresponding visual graphic in the visual field of the wearer. For example, high frequencies may be displayed in a first direction, and low frequencies may be displayed in a different, second direction. As another example, sounds with different spectral content can be represented by visual graphics in different portions of the 4π steradians of solid angle surrounding the wearer's head (including in directions for which the wearer would have to turn around to see or hear).

[0059] Thus, a wearer of the HMD can selectively choose a desired mix of the audio tracks. For example, if the stem tracks correspond to vocals, guitar, bass, and drums, the wearer could listen to (or see a visual representation of) just one of the stem tracks (e.g., just the vocals or just the guitar). Alternatively, the wearer could move his or her head or

eyes, and listen to (or see) a different mix of the audio file tracks. In some implementations, the wearer can mute an audio track by using an appropriate gesture (e.g., a hand gesture). For example, the wearer may want to listen to a guitar solo and might mute all tracks except the guitar track.

[0060] The views 104, 108 may be presented in a VR mode of display, where the wearer sees the visual graphics 104a-104e or 108a-108e, but not the outside world 144. Alternatively, the views 104, 108 may be presented in an AR mode of display, where the wearer sees the visual graphics 104a-104e or 108a-108e superimposed on the outside world 144.

[0061] As an example of a wearer interacting with the views 104, 108 shown in FIG. 7A in an AR mode of display, a disc jockey (DJ) can use hand gestures to control individual sound characteristics (e.g., volume) of the stem tracks, as they are displayed by an HMD. A DJ utilizing the HMD may “grab” one of the graphics, such as the graphic 104a, to control the volume of that stem track. Continuing in this example, if the graphic 104a represents the vocals track, the DJ may compress her hand to reduce the volume of that stem track. Other sound characteristics of the stem track may be altered or modified, as described above. For example, if the DJ were to select a different sound characteristic mode (e.g., by making some other hand gesture), the DJ could also alter or modify another sound characteristic of the vocals track represented by the graphic 104a. Continuing in this example, if the sound characteristic mode is changed to pitch, the DJ compressing her hand in this case would decrease the pitch. If, on the other hand, the DJ wanted to increase the pitch, the DJ may use another hand gesture to increase the pitch associated with the graphic 104a. For example, the DJ may “spin” the graphic 104a by moving her hand quickly in either a clockwise or counterclockwise direction in an area associated with the graphic 104a (e.g., on or near the graphic).

[0062] Other sound characteristics that may alter or modify the various stem tracks are possible. For example, other sound characteristics can include volume, pitch, bass, treble, tonal quality, intensity, duration, etc. Although the foregoing example has been described in the context of hand gestures, other body gestures can be used to control the sound characteristics of stem tracks appearing on the display of an HMD. Additionally or alternatively, some stem tracks may be displayed in a VR mode. Gestures can also be used

to alter or modify the stem tracks displayed in that VR mode. As but one example, a DJ may tap one of their feet twice (e.g., tapping a foot twice within a certain time period of a first tap) to indicate that a sound characteristic of a stem track is to be altered or modified. Generally, various embodiments of gestures may be used to interact with the visual display. While the foregoing example has been described in terms of gestures, control signals from an external device may also alter stem tracks. For example, a wearer may utilize a joystick, totem, or touch-sensitive input device to alter the pitch of a particular stem track being represented as a visual graphic.

[0063] A stem track or portion thereof may also be generated by a wearer of the HMD. For example, a user generated stem track can replace the corresponding one (or more) stem track of an audio recording. For example, the user can substitute the user's stem track for one of the audio's original stem tracks. As an example, a user can record a vocal track (of the user or someone else) and substitute the user vocal track for the original vocal track of the recording. Thus, the stem tracks being played may sound as if the user is singing on the audio recording. In another embodiment, if two stem tracks correspond to respective vocal tracks of a duet, a user generated vocal stem track can replace one of the voices in a duet. As yet another example, a user generated guitar solo can replace the corresponding guitar stem track of an audio recording. Any number of the audio stem tracks can be replaced, in whole or in part, with user generated stem tracks.

[0064] FIG. 7B schematically illustrates an example of an AR presentation 750 of an audio file comprising stem tracks. In this example, the wearer looks through the HMD display 62 out into a room 160 that contains a real (physical) object – a sofa 164a. Only one physical object is shown in FIG. 7B for illustrative purpose but this is not a limitation.

[0065] In this example, the stem tracks correspond to vocals, guitar, bass, and drums. The HMD presents a visual graphic 164b in the form of a person playing a guitar for the guitar track, a visual graphic 176 in the form of a person playing a bass guitar for the bass track, a visual graphic 168 in the form of a person singing for the vocal track, and a visual graphic 172 in the form of a person playing a drum set for the drum track. Similar to the views 700 shown in FIG. 7A, the different visual graphics 164b, 168, 172, and 176 are displayed in different directions in the room 160. In this AR presentation, the visual graphic 164b for the guitar player is presented as if the guitar player were sitting on the (physical)

sofa 164a that is actually present in the room 160. The visual graphics 168, 172, and 176 are presented in regions of the room where there are no physical objects.

[0066] Since embodiments of the HMD described herein are capable of presenting objects at multiple depth planes in the wearer's visual field (see, e.g., the discussion of FIG. 3, the waveguides 182, 184, 186, 188, 190 in the waveguide assembly 178 of the display system 100 of FIG. 4, or the waveguide 1 of the display system 100 of FIG. 6), the view 750 shows the different visual graphics 164b, 168, 172, and 176 at different depths in the room. For example, the bass guitarist (the visual graphic 176) is toward the front of the room 160, the lead singer (the visual graphic 168) is farther back in the room 160 but forward of the drummer (the visual graphic 172), who is at the back of the room, farthest from the wearer. Additionally, in this example, the amount of detail in the different visual graphics can depend on depth. For example, since the drummer (the visual graphic 172) appears as being farthest from the wearer, the visual graphic 172 has less detail than the visual graphics 168 and 176, which appear as closer to the wearer. In embodiments where the audio file includes additional information relating to movement (e.g., of the lead singer), the HMD can present the visual graphic 168 representing the singer as moving around in the room 160.

[0067] The example view 750 illustrated in FIG. 7B accordingly shows an example in which the different stem tracks are represented visually in the external world environment 144 of the wearer. The HMD may recognize objects in the environment 144 (e.g., the sofa 164a in the room 160) or may be in communication with totems or electronic trackers disposed in the environment 144 that can be used to assist in the display of the visual graphics. For example, a visual graphic for a particular stem track may be visualized at the position of a totem in the room 160. Additionally or alternatively, as described above with respect to the example of interacting with the visual display to control a sound characteristic, the visual graphics may also be modified or altered in a VR or AR mode of display using gestures. As but one example, in an AR mode of display, an HMD wearer may depress her hand on the bass guitarist, e.g. the visual graphic 176, to depress the bass associated with the sound of the soundtrack played by the visual graphics 164b, 168, 172, and 176. Continuing in this example, the resulting display of the visual graphic 176 may appear smaller than the other graphics 164b, 168, or 172. As another example, if the gestures of a wearer control the

volume characteristic of the soundtrack played by the visual graphics 164b, 168, 172, and 176, the wearer may “grab” and “drag” the drummer, e.g. the visual graphic 172 toward the front of the room 160 to increase the volume of the drums. Conversely, to decrease the volume of the vocals, a wearer may “push back” the graphic 168 towards the back of the room 160 (or pull the graphic forward to increase the volume).

[0068] The visual graphics may also be modified or altered in a VR or AR mode of display using gestures other than a wearer’s hands. For example, other sensors coupled to the wearable display system 100, such as inertial measurement units (IMUs), may be used to detect gestures of the wearer. For example, an inertial measurement unit may detect the wearer nodding her head backwards and forwards, which may correspond to a head gesture. Accordingly, a wearer nodding her head backwards and forwards once can indicate the selection of one of the graphics 164b, 168, 172, and 176. In some cases, a sufficiently “sharp” head movement (e.g., IMU measurement above a threshold) may indicate a selection of the graphic, whereas a more gentle head movement (IMU measurement below a threshold) may indicate adjustment of a property associated with the graphic. Continuing in the example from above, while the wearer is “pushing back” the graphic 168 towards the back of the room 160, the wearer may nod her head towards the visual graphic 176 to indicate the selection of the visual graphic 176, e.g., the bass stem track. Once selected, the wearer can alter that stem track in some way (e.g., dampen the bass stem track), or as described above with respect to changes of the sounds characteristics of stem tracks. Additionally or alternatively, while altering a selected stem track with gestures, the wearer may also perform the particular stem track and replace that corresponding stem track for the audio track being played by the wearable display system 100 (e.g., as described above with respect to the example of replacing stem tracks). For example, the wearer may replace the vocals of the graphic 168, while simultaneously altering other stem tracks represented by the other visual graphics, e.g., the visual graphic 176 representing the bass stem track. Further, body gestures besides head or hand gestures can be used. For example, a foot gesture (e.g., tapping a foot) may indicate stepping on a guitar or drum pedal, hitting a drum, actuating an audio effect (e.g., reverb), and so forth.

[0069] FIG. 7C schematically illustrates another example of a view 780 that can be presented by an HMD. In this example, the audio track is a string quartet (two violins,

one viola, and one cello) playing a piece of chamber music. As the wearer listens to the audio track, the HMD presents the view 780 to the wearer and shows visual graphics 184 and 188 representing the violins, visual graphic 192 representing the cello, and visual graphic 196 representing the viola. As the wearer's head or eye pose changes, a different mix of these four instruments is presented audibly to the wearer. For example, if the wearer looks toward the direction of the violins 184, 188, the wearer may hear audio in which the violin sounds are emphasized over the cello and viola sounds (which may be muted or played at lower volumes than the violins). The visual graphics 184, 188 for the violins may correspondingly be emphasized with respect to the visual graphics 192, 196 for the cello and viola. For example, the bows of the violins may be displayed as moving while the bows for the cello and viola may be shown as not moving. Although in this example, the visual graphics 184, 188, 192, and 196 appear as displayed at a common depth plane, this is not a limitation and in other example, the visual graphics representing the different instruments can be presented at different depth planes from the wearer.

[0070] Visual graphics displayed by an HMD may also be used as an HMD generated user interface (UI). For example, the view 780 may present various stem tracks that the wearer may use to interact with the stem track in the particular fashion that that stem track is being represented or displayed. A particular UI object may be a representation of what may be altered or modified. As an example in an AR mode of display, if the wearer "grabs" the viola 196 (e.g., "grabs" the viola as described above with respect to the example of interacting with graphics displayed in AR mode), the wearer may "play" the viola to modify a characteristic of the viola sounds. Continuing in the example, after the wearer "grabs" the viola, the wearer may use an HMD generated "bow" to "play" the viola, thereby modifying a characteristic of a viola sound (e.g., volume). As another example of an AR mode of display, the wearer may "play" the viola to replace the corresponding viola stem track being played. For example, the wearer may use an HMD generated "bow" to play the viola and generate a viola stem track. In one embodiment, this wearer generated viola stem track may replace the viola stem track in string quartet, so that the resulting audible sounds to the wearer is the wearer playing the viola portion of a string quartet.

[0071] Although the foregoing example has been described in the context of visual graphics of chamber instruments, other visual graphics may act as a UI to alter or

modify the object for which the generated UI represents. For example, for audio tracks with electric guitars, the UI may include a representation of an electric guitar having strings, switches, and knobs. The wearer may pluck or strum the guitar strings, adjust the toggle switches, or rotate the knobs to control various aspects of the audio track. The visual graphic may be a skeuomorphic representation of the object to be modified. For example, a telephone graphic including a number keypad may represent a dialing function associated with the HMD so that the wearer can dial a telephone number. As another example, an AR representation of a calendar may emulate the appearance of binding on a paper desk calendar. Generally speaking, any visual graphic object generated by an HMD may be used as a user interface.

Conclusion

[0072] Each of the processes, methods, and algorithms described herein and/or depicted in the attached figures may be embodied in, and fully or partially automated by, code modules executed by one or more physical computing systems, hardware computer processors, application-specific circuitry, and/or electronic hardware configured to execute specific and particular computer instructions. For example, computing systems can include general purpose computers (e.g., servers) programmed with specific computer instructions or special purpose computers, special purpose circuitry, and so forth. A code module may be compiled and linked into an executable program, installed in a dynamic link library, or may be written in an interpreted programming language. In some implementations, particular operations and methods may be performed by circuitry that is specific to a given function.

[0073] Further, certain implementations of the functionality of the present disclosure are sufficiently mathematically, computationally, or technically complex that application-specific hardware or one or more physical computing devices (utilizing appropriate specialized executable instructions) may be necessary to perform the functionality, for example, due to the volume or complexity of the calculations involved or to provide results substantially in real-time. For example, a video may include many frames, with each frame having millions of pixels, and specifically programmed computer hardware is necessary to process the video data to provide a desired image processing task or application in a commercially reasonable amount of time.

[0074] Code modules or any type of data may be stored on any type of non-transitory computer-readable medium, such as physical computer storage including hard drives, solid state memory, random access memory (RAM), read only memory (ROM), optical disc, volatile or non-volatile storage, combinations of the same and/or the like. The methods and modules (or data) may also be transmitted as generated data signals (e.g., as part of a carrier wave or other analog or digital propagated signal) on a variety of computer-readable transmission mediums, including wireless-based and wired/cable-based mediums, and may take a variety of forms (e.g., as part of a single or multiplexed analog signal, or as multiple discrete digital packets or frames). The results of the disclosed processes or process steps may be stored, persistently or otherwise, in any type of non-transitory, tangible computer storage or may be communicated via a computer-readable transmission medium.

[0075] Any processes, blocks, states, steps, or functionalities in flow diagrams described herein and/or depicted in the attached figures should be understood as potentially representing code modules, segments, or portions of code which include one or more executable instructions for implementing specific functions (e.g., logical or arithmetical) or steps in the process. The various processes, blocks, states, steps, or functionalities can be combined, rearranged, added to, deleted from, modified, or otherwise changed from the illustrative examples provided herein. In some embodiments, additional or different computing systems or code modules may perform some or all of the functionalities described herein. The methods and processes described herein are also not limited to any particular sequence, and the blocks, steps, or states relating thereto can be performed in other sequences that are appropriate, for example, in serial, in parallel, or in some other manner. Tasks or events may be added to or removed from the disclosed example embodiments. Moreover, the separation of various system components in the implementations described herein is for illustrative purposes and should not be understood as requiring such separation in all implementations. It should be understood that the described program components, methods, and systems can generally be integrated together in a single computer product or packaged into multiple computer products. Many implementation variations are possible.

[0076] The processes, methods, and systems may be implemented in a network (or distributed) computing environment. Network environments include enterprise-wide computer networks, intranets, local area networks (LAN), wide area networks (WAN),

personal area networks (PAN), cloud computing networks, crowd-sourced computing networks, the Internet, and the World Wide Web. The network may be a wired or a wireless network or any other type of communication network.

[0077] The systems and methods of the disclosure each have several innovative aspects, no single one of which is solely responsible or required for the desirable attributes disclosed herein. The various features and processes described above may be used independently of one another, or may be combined in various ways. All possible combinations and subcombinations are intended to fall within the scope of this disclosure. Various modifications to the implementations described in this disclosure may be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other implementations without departing from the spirit or scope of this disclosure. Thus, the claims are not intended to be limited to the implementations shown herein, but are to be accorded the widest scope consistent with this disclosure, the principles and the novel features disclosed herein.

[0078] Certain features that are described in this specification in the context of separate implementations also can be implemented in combination in a single implementation. Conversely, various features that are described in the context of a single implementation also can be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination. No single feature or group of features is necessary or indispensable to each and every embodiment.

[0079] Conditional language used herein, such as, among others, “can,” “could,” “might,” “may,” “e.g.,” and the like, unless specifically stated otherwise, or otherwise understood within the context as used, is generally intended to convey that certain embodiments include, while other embodiments do not include, certain features, elements and/or steps. Thus, such conditional language is not generally intended to imply that features, elements and/or steps are in any way required for one or more embodiments or that one or more embodiments necessarily include logic for deciding, with or without author

input or prompting, whether these features, elements and/or steps are included or are to be performed in any particular embodiment. The terms “comprising,” “including,” “having,” and the like are synonymous and are used inclusively, in an open-ended fashion, and do not exclude additional elements, features, acts, operations, and so forth. Also, the term “or” is used in its inclusive sense (and not in its exclusive sense) so that when used, for example, to connect a list of elements, the term “or” means one, some, or all of the elements in the list. In addition, the articles “a,” “an,” and “the” as used in this application and the appended claims are to be construed to mean “one or more” or “at least one” unless specified otherwise.

[0080] As used herein, a phrase referring to “at least one of” a list of items refers to any combination of those items, including single members. As an example, “at least one of: A, B, or C” is intended to cover: A, B, C, A and B, A and C, B and C, and A, B, and C. Conjunctive language such as the phrase “at least one of X, Y and Z,” unless specifically stated otherwise, is otherwise understood with the context as used in general to convey that an item, term, etc. may be at least one of X, Y or Z. Thus, such conjunctive language is not generally intended to imply that certain embodiments require at least one of X, at least one of Y and at least one of Z to each be present.

[0081] Similarly, while operations may be depicted in the drawings in a particular order, it is to be recognized that such operations need not be performed in the particular order shown or in sequential order, or that all illustrated operations be performed, to achieve desirable results. Further, the drawings may schematically depict one more example processes in the form of a flowchart. However, other operations that are not depicted can be incorporated in the example methods and processes that are schematically illustrated. For example, one or more additional operations can be performed before, after, simultaneously, or between any of the illustrated operations. Additionally, the operations may be rearranged or reordered in other implementations. In certain circumstances, multitasking and parallel processing may be advantageous. Moreover, the separation of various system components in the implementations described above should not be understood as requiring such separation in all implementations, and it should be understood that the described program components and systems can generally be integrated together in a single software product or packaged into multiple software products. Additionally, other implementations are within the scope of

the following claims. In some cases, the actions recited in the claims can be performed in a different order and still achieve desirable results.

WHAT IS CLAIMED IS:

1. A wearable display device comprising:
 - non-transitory memory configured to store an audio file comprising a plurality of stem tracks, with each stem track representing different audio content of the audio file;
 - a sensor configured to measure information associated with a pose of the wearer of the wearable display device;
 - a display configured to present images to an eye of the wearer of the wearable display device;
 - a speaker configured to present sounds to the wearer of the wearable display device; and
 - a processor in communication with the non-transitory memory, the sensor, the speaker, and the display, the processor programmed with executable instructions to:
 - determine the pose of the wearer;
 - generate, based at least partly on the pose of the wearer, an audio mix of at least one of the plurality of stem tracks of the audio file;
 - generate, based at least partly on the pose of the wearer and the audio mix, a visualization of the audio mix;
 - communicate an audio signal representative of the audio mix to the speaker; and
 - communicate a visual signal representative of the visualization of the audio mix to the display.
2. The wearable display device of claim 1, wherein the plurality of stem tracks comprises at least four stem tracks.
3. The wearable display device of claim 1 or claim 2, wherein the plurality of stem tracks represent a plurality of tracks for different musical instruments.
4. The wearable display device of claim 3, wherein the plurality of stem tracks further represents a vocal track.
5. The wearable display device of claim 4, wherein the plurality of stem tracks represents a guitar, a bass guitar, a drum, and a voice.

6. The wearable display device of any one of claims 1-5, wherein the sensor comprises an eye-tracking camera, a gyroscope, an accelerometer, or an inertial measurement device.

7. The wearable display device of any one of claims 1-6, wherein the pose comprises a head pose, an eye pose, or both a head pose and an eye pose.

8. The wearable display device of any one of claims 1-7, wherein the pose comprises a gesture of the wearer.

9. The wearable display device of any one of claims 1-8, wherein the display is configured to present a plurality of depth planes to the wearer.

10. The wearable display device of any one of claims 1-9, wherein the display is configured to present a light field image to the wearer.

11. The wearable display device of any one of claims 1-10, wherein the display comprises a plurality of stacked waveguides.

12. The wearable display device of any one of claims 1-11, wherein the visualization comprises a visual graphic associated with each of the plurality of stem tracks.

13. The wearable display device of claim 12, wherein the visual graphic comprises a graphical representation of an instrument or person associated with performance of the stem track.

14. The wearable display device of claim 12 or claim 13, wherein at least some of the visual graphics are presented at different depth planes relative to the wearer.

15. The wearable display device of any one of claims 12-14, wherein the wearable display device is configured to recognize a physical object in the vicinity of the wearer, and to present a graphical representation as being associated with the physical object.

16. The wearable display device of any one of claims 1-15, wherein the wearable display device is configured to receive input from an electronic component, and the processor is configured to generate the audio mix or the visualization based at least in part on the input.

17. A method for interacting with an augmented reality object, the method comprising:

under control of a hardware computer processor:

generating an augmented reality object for interaction by a wearer of the wearable display system, wherein the augmented reality object includes an interface for modification of a characteristic associated with the augmented reality object and displayed on a display of the wearable display system;

detecting gestures of a wearer while the wearer interacts with the interface;

associating the detected gestures with a modification to a characteristic of the augmented reality object; and

modifying the augmented reality object in accordance with the modification to the characteristic of the augmented reality object.

18. The method of claim 17, wherein detecting the gestures of the wearer while the wearer interacts with the interface comprises:

capturing, with an outward facing image capture device of the wearable display system, a first image of a hand of the wearer;

capturing, with the outward facing image capture device of the wearable display system, a second image of a hand of the wearer; and

comparing the first image and the second image to detect a gesture of the wearer

19. The method of claims 17 or 18, wherein the augmented reality object represents a telephone, and wherein the interface corresponds to the number keypad.

20. The method of any one of claims 17-19, wherein associating the detected gestures with a modification to a characteristic of the augmented reality object comprises associating finger depressions on the telephone to modify the appearance of the number keypad.

21. The method of any one of claims 17-20, wherein modifying the augmented reality object in accordance with the modification to the characteristic of the augmented reality object comprises representing the number keypad with sequential depressions display on the keypad corresponding to the associated finger depressions.

22. The method of any one of claims 17-21, wherein the interface of the augmented reality object corresponds to a skeuomorphic representation of the augmented reality object.

23. The method of any one of claims 17-22, wherein the augmented reality object corresponds to a musical instrument or a person playing a musical instrument

24. The method of any one of claims 17-23, wherein associating the detected gestures with the modification to the musical instrument or the person playing the musical instrument comprise detecting hand or finger movements of the wearer interacting with the musical instrument to increase an attribute of a stem track associated with the musical instrument.

25. The method of any one of claim 17-24, wherein the stem track associated with the musical instrument is one of a plurality of stem tracks being played an audio system coupled to the wearable display system.

26. The method of any one of claim 17-25, wherein an audio track comprises the plurality of stem tracks, wherein at least one of the plurality of stem tracks is an original stem track replaced by a user generated stem track.

27. The method of any one of claim 17-26, wherein an additional augmented reality object is selected with a head gesture of the wearer for alteration of the corresponding stem track represented by the additional augmented reality object.

28. A wearable display system for interacting with a visual graphic, the system comprising:

- a display configured to display the visual graphic;

- at least one outward facing camera configured to image a region in front of the wearable display system; and

- a computer processor configured to communicate with a network and programmed to:

- generate the visual graphic for interaction by a wearer of a wearable display system, wherein the visual graphic includes an interface for modification of a characteristic associated with the visual graphic;

- detect gestures of a wearer interacting with the wearable display system;

- associate the detected gestures with a modification to a characteristic of the visual graphic; and

alter the visual graphic in accordance with the modification to the characteristic of the visual graphic.

ABSTRACT OF THE DISCLOSURE

Examples of wearable display devices that can present to a wearer of the display device an audible or visual representation of an audio file comprising a plurality of stem tracks that represent different audio content of the audio file are described. Systems and methods are described that determine the pose of the wearer; generate, based on the pose of the wearer, an audio mix of at least one of the plurality of stem tracks of the audio file; generate, based on the pose of the wearer and the audio mix, a visualization of the audio mix; communicate an audio signal representative of the audio mix to the speaker; and communicate a visual signal representative of the visualization of the audio mix to the display.

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Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		HEAD POSE MIXING OF AUDIO FILES		
First Named Inventor/Applicant Name:		Stephen V. Mangiat		
Filer:		Andrew F. Quecan/Thomas Chmura		
Attorney Docket Number:		MLEAP.012PR2		
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Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Provisional Application Filing	1005	1	260	260
Pages:				
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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 (\$)				260

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File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS_MLEAP012PR2.PDF	1822718	no	8
			44eb9ee35084496145f7a39a364acc674a0a f043		
Warnings:					
Information:					
2	Drawings-only black and white line drawings	Drawings_MLEAP012PR2.PDF	642758	no	9
			62517a1f0995188066856ee2cc9139e6a12c d5c5		
Warnings:					
Information:					
3		Spec_MLEAP012PR2.pdf	161071	yes	34
			320ec0177bb11968a1643fb2b97f5d7620b 1861b		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Specification		1	28	
	Claims		29	33	
	Abstract		34	34	
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	29953	no	2
			36769364b221665bb25d068fead77075817 00be4		
Warnings:					
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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.