THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL

# Vision & Virtual/Augmented Reality Technologies

## 9,983,412 Wide Field of View Augmented Reality Head-Mounted Display with Distance Accommodation

Provides a wide field of view HMD with optical see-through capability and also dynamically adaptive distance accommodation. This would match the optical distance of the computer-generated image to the optical distance of the wearer's gaze. (16-0189)

## 9,898,866 Low-Latency Stabilization for Head-Worn Displays

A redesigned device platform with clusters of cameras help to incorporate just-in-time sensing with just-in-time rendering, enabling augmented reality applications to thrive. (13-0056)


## 9,858,721 Optical See-Through Head Worn Display Using Multiple Light Attenuating Layers

New optical see-through glasses have been developed that integrate virtual imagery with high visual fidelity into a compact slim display that supports a wide field of view. The use of multiple imaging masking layers allows for simultaneous viewing of real-world objects and virtual objects that can be implemented for several purposes in the realm of augmented reality. (13-0039)

## 9,208,612 Vertical Fusion of 2.5D Depth Information

A method has been developed for the generation of a fused 3D model from multiple 2.5D data sources representing depth measurements. Efficiency gains occur because the fusion is performed in 2.5 D instead of 3D, thereby reducing its complexity tremendously. (10-0086)

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# Sound Simulation Technologies

9,977,644

## Interactive Sound Propagation and Rendering for Scenes with High Aural Complexity

An interactive algorithm for accelerated sound propagation and rendering in complex, dynamic scenes with a large number of sources has been developed. The algorithm can be used to generate indoor and outdoor scenes with high aural complexity more quickly than other algorithms. (15-0003)

9,906,884

## Simulation of Head-Related Transfer Functions Using Adaptive Rectangular Decomposition

This methodology uses a novel sound simulation technique to generate personalized HRTFs using 3-D scans of human heads. The technique utilizes Adaptive Rectangular Decomposition (ARD) - based sound simulation. (13-0119)

9,824,166

## A Parallel ARD-based Wave Simulator for Distributed Memory Architectures

A new, distributed time-domain simulator has been developed that performs fast, accurate acoustic simulation in large, complex 3D scenes such as outdoor or architectural environments. (14-0093)

9,711,126

## Sound Propagation in Large Scenes Using Equivalent Sources

A new object-centric algorithm for wave-based sound propagation that captures acoustic effects such as high-order diffraction and scattering using an equivalent source formulation has been developed. The technique can perform accurate sound propagation on large, open scenes in real-time, has a small memory footprint, and allows flexible efficiency-accuracy tradeoffs. (12-0052)

9,401,684

## Example-Guided Sound Synthesis

A new method for sound synthesis using estimated material parameters has been developed that recreates realistic audio for virtual objects. The estimated material parameters and the residual compensation naturally transfer to virtual objects of different sizes and shapes. (12-0086)

8,847,965

## Fast Geometric Sound Propagation Using Visibility Computations

A new method for simulation of sound propagation has been developed that harnesses geometric acoustics and conservative visibility techniques to quickly and accurately compute sound propagation paths of complex scenes. (11-0047)

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# Virtual Environments Technologies

## 9,792,715 Concepts for Deformable Heads and Faces on Human Avatars

Synthetic animatronics aims to achieve the effect of a moving/animatronic head but without the use of a computer-controlled pan/tilt unit or any similar electro-mechanical actuation. A concept has been developed for a display surface that is appropriately shaped such that when human faces are projected on it in different locations (on the surface) it appears to nearby viewers that the head is nodding yes/no or turning left/right, for example. (12-0131)

## 9,538,167 Shader-Lamps Based Physical Avatars of Real and Virtual People

These methods and systems dynamically capture appearance, shape, and posture of either real or virtual humans and then re-map the captured signals to a physical embodiment of the real/virtual human (e.g., an animatronic mannequin). The results are then projected onto the physical embodiment, which may be stationary or have moving parts, thereby animating features of the mannequin. (09-0085)

## 9,361,727 Multi-User Autostereo Display

This methodology improves a 3-D display, allowing simultaneous projection of different 3-D images to viewers at different positions in front of a 3-D display. More specifically, it reduces annoying distortions that viewers would otherwise experience when viewing conventional multi-user 3-D displays. (09-0084)

## 8,152,305 Full Spectrum Projection

Full Spectrum Projector utilizes a prism to split white light into a “rainbow” prism band. Sweeping the rainbow across a DMD device (mirror) allows each pixel to see every color instead of a single monotonic light. As a result, each pixel can show colors of any frequency projected from the prism. Applications include internal 3D measurement (04-0069)

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| Patent | Title | Inventors |
|---|---|---|
| 9,983,412 | Wide Field of View Augmented Reality Head-Mounted Display with Distance Accommodation | Henry Fuchs, David Dunn, Cary Tippets |
| 9,898,866 | Low-Latency Stabilization for Head-Worn Displays | Henry Fuchs, Nate Dierk, Jan-Michael Frahm, Anselmo Lastra, David Perra |
| 9,858,721 | Methods, Systems, and Computer Readable Media for Generating an Augmented Scene Display | Andrew Maimone, Henry Fuchs |
| 9,208,612 | Systems and Methods that Generate Height Map Models for Efficient Three Dimensional Reconstruction from Depth Information | Jan-Michael Frahm, David Gallup, Marc Pollefeys |
| 9.906.884 | Methods, Systems, and Computer Readable Media for Utilizing Adaptive Rectangular Decomposition (ARD) to Generate Head-Related Transfer Functions | Alok Meshram, Enrique Dunn Rivera, Jan-Michael Frahm, Dinesh Manocha, Ravish Mehra, Hongsheng Yang |
| 9,977,644 | Methods, Systems, and Computer Readable Media for Conducting Interactive Sound Propagation and Rendering for A Plurality of Sound Sources in a Virtual Environment Scene | Dinesh Manocha, Carl Schissler |
| 9,824,166 | Methods, Systems, and Computer Readable Media for Utilizing Parallel Adaptive Rectangular Decomposition (ARD) to Perform Acoustic Simulations | Nicolas Morales, Dinesh Manocha, Ravish Mehra |
| 9,711,126 | Methods, Systems, and Computer Readable Media for Simulating Sound Propagation in Large Scenes Using Equivalent Sources | Ravish Mehra, Dinesh Manocha |
| 9,401,684 | Methods, Systems, and Computer Readable Media for Synthesizing Sounds Using Estimated Material Parameters | Ming Lin, Zhimin Ren, Hengchin Yeh |
| 8,847,965 | Methods, Systems and Computer Readable Media for Fast Geometric Sound Propagation Using Visibility Computations | Dinesh Manocha, Lakulish Antani, Anish Chandak, Micah Taylor |
| 9,792,715 | Methods, Systems, and Computer Readable Media for Utilizing Synthetic Animatronics | Gregory Welch, Henry Fuchs, Kurtis Keller, Ryan Schubert, Andrei State |
| 9,538,167 | Methods, Systems, and Computer Readable Media for Shader-Lamps Based Physical Avatars of Real and Virtual People | Gregory Welch, Henry Fuchs, Peter Lincoln, Andrew Nashel, Andrei State |
| 9,361,727 | Methods, Systems, and Computer Readable Media for Generating Autostereo Three-Dimensional Views of a Scene for a Plurality of Viewpoints Using a Pseudo-Random Hole Barrier | Henry Fuchs, Leonard McMillan, Andrew Nashel |
| 8,152,305 | Methods, Systems, and Computer Program Products for Full Spectrum Projection | Kurtis Keller, Henry Fuchs, Leonard McMillan |

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