Manu Gopakumar

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EDUCATION

Stanford University, Stanford, CA — August 2020-Present

- PhD in Electrical Engineering (GPA: 4.18)

Carnegie Mellon University, Pittsburgh, PA — August 2019-May 2020

- Master of Science in Electrical and Computer Engineering (QPA: 4.00)

Carnegie Mellon University, Pittsburgh, PA — August 2016-May 2019

- Bachelor of Science in Electrical and Computer Engineering (QPA: 4.00)

UNIVERSITY RESEARCH

Full-colour Metasurface Waveguide Holography: May 2022-May 2024

- Developed a holographic AR system that pairs inverse-designed full-colour metasurface gratings with a dispersion-compensating waveguide geometry for compact optical see-through augmented reality glasses
- Demonstrated full-colour high quality 3D holograms through a waveguide using an AI image formation model that combines a physically accurate waveguide model with learned components that are automatically calibrated using camera feedback
- Joint first author for publication in Nature [1]

Time-Multiplexed Neural Holography: September 2021-January 2022

- Developed AI framework for optimizing holograms displayed on highly-quantized high speed MEMs-based spatial light modulators
- Demonstrated state-of-the-art natural defocus and high image quality for dynamic holographic displays with a variety of content types
- Joint first author for publication at SIGGRAPH [2]

Neural 3D Holography: December 2020-May 2021

- Developed neural network based forward model to model aberrations produced in physical setup
- Used forward model to generate high quality 3D content for holographic displays
- Joint first author for publication at SIGGRAPH Asia [5]

Cell-type Selective Neuron Stimulation: December 2017-November 2019

- Implemented and analyzed models for specific mammalian neuron cell types
- Designed and implemented strategies for selectively stimulating specific neuron models
- Collaborated with biological and experimental groups to test strategies on brain slices
- Published strategies at IEEE EMBS Conference on Neural Engineering [6]

INDUSTRY RESEARCH

Research Internship with NVIDIA, Santa Clara, CA: May 2021-September 2021

- Developed algorithmic framework for optimizing high-quality holograms in compact filter-free holographic displays
- Published details in Optics Letters [4]
- Assisted on and presented subsequent SIGGRAPH publication using this algorithmic framework to enable ultra-thin holographic virtual reality glasses [3]

PROJECTS

Depth and All-in-focus Imaging with Coded Aperture: October 2019-December 2019

- Developed all-in-focus image and depth estimation pipeline for coded aperture cameras
- Fabricated coded aperture to capture and process coded aperture images

Uncertainty-aware Monocular Visual Odometry: October 2019-December 2019

- Utilized neural networks to estimate monocular depth with uncertainty as a classification problem
- Used depth estimation to generate point clouds and adapted Iterative Closest Point (ICP) to account for uncertainty while estimating pose

TEACHING AND MENTORSHIP

SHTEM Summer Internship Mentor: June 2022-August 2022

- Mentored a group of high school students through the Stanford SHTEM internship program
- Guided interns on a project developing Unity scripts for on-demand custom light field datasets that the students packaged as a paper accepted to the 2022 IEEE MIT URTC

EE267 Virtual Reality Course Assistant April 2022-June 2022, April 2024-June 2024

- Teaching assistant for course that details the hardware and software foundations of virtual reality
- Guided students through student-proposed final projects and problem sets emphasizing hands-on programming of VR headsets from shading computation to IMU-based tracking

REFERENCES

Gordon Wetzstein (email: gordonwz@stanford.edu)
Jonghyun Kim (email: jonghyunk@nvidia.com)
Aswin Sankaranarayanan (email: saswin@andrew.cmu.edu)
Pulkit Grover (email: pgrover@andrew.cmu.edu)

RELEVANT COURSEWORK

Fundamentals of Signal Processing	Cloud Computing	Image and Video Processing
Intro. to Embedded Systems	Optimization	Geometry-based Methods in Vision
Computational Photography	Nano-Bio-Photonics	Physics-based Methods in Vision
Visual Computing Systems	Modern Optics	Interactive Computer Graphics
Computer Graphics in the Era of AI	Virtual Reality	Neural Models for 3D Geometry

Selected Publications

[1] **Gopakumar, M.***, Lee, G. Y.*, Choi, S., Chao, B., Peng, Y., Kim, J., & Wetzstein, G. (2024). Full-colour 3D holographic augmented-reality displays with metasurface waveguides. *Nature*, 1-7.

[2] Choi, S.*, **Gopakumar, M.***, Peng, Y., Kim, J., O'Toole, M., & Wetzstein, G. (2022, July). Time-multiplexed Neural Holography: A flexible framework for holographic near-eye displays with fast heavily-quantized spatial light modulators. In *ACM SIGGRAPH 2022 Conference Proceedings* (pp. 1-9).

[3] Kim, J., **Gopakumar, M.**, Choi, S., Peng, Y., Lopes, W., & Wetzstein, G. (2022, July). Holographic glasses for virtual reality. In *ACM SIGGRAPH 2022 Conference Proceedings* (pp. 1-9).

[4] **Gopakumar, M.**, Kim, J., Choi, S., Peng, Y., & Wetzstein, G. (2021). Unfiltered holography: optimizing high diffraction orders without optical filtering for compact holographic displays. *Optics Letters*, *46*(23), 5822-5825.

[5] Choi, S.*, **Gopakumar, M.***, Peng, Y., Kim, J., & Wetzstein, G. (2021). Neural 3D holography: Learning accurate wave propagation models for 3D holographic virtual and augmented reality displays. *ACM Transactions on Graphics (TOG)*, *40*(6), 1-12.

[6] **Gopakumar, M.**, Cao, J., Kelly, S. K., & Grover, P. (2019, March). Cell-type Selective Stimulation of Neurons Based on Single Neuron Models. In *2019 9th International IEEE/EMBS Conference on Neural Engineering (NER)* (pp. 411-414). IEEE.

*denotes equal contribution