Victor Liu

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Interests

I am somewhere between an engineer, computational physicist, geometer, and mathematician. My interests are in applying cutting edge computational mathematical techniques to develop custom modeling/simulation methods. I enjoy working close to the metal, using the right representation, and designing a proper UX for simulation tools.

Education

Stanford University, Stanford, CA *2007 - 2013*
Ph.D. in electrical engineering.
Research Advisor: Prof. Shanhui Fan

California Institute of Technology, Pasadena, CA *Sept. 2003 - 2007*
B.S. in electrical engineering.
Research advisor: Prof. Axel Scherer

Employment

Lead Diffractive Optics Engineer, Magic Leap *2015–present*

- Developed state-of-the-art modeling capabilities for diffractive waveguide combiner technology (nanophotonics at macro-scale; ∼80 kSLOC C++ engine + ∼14 kSLOC Python interface, OpenGL visualizer, libraries, and cloud infrastructure).
- Developed custom layout toolchain to leverage and automate semiconductor process technology for fabrication of large-area diffractive optics of unprecedented complexity. (Custom C++ geometry kernel + Python interface).
- Developed mathematical theory and patents supporting R&D efforts.

Member of the Research Staff, Palo Alto Research Center *2014–2015*
Metamaterials Devices and Applications group.

- Developed tailored simulation methods for radar absorbing materials.
- Designed and built prototypes of phased array antennas.
- Built data analysis tools for residential energy efficiency.
- Research on photonic crystal sensors for gas leak detection, focused magnetic stimulation for neural interfacing, and large scale theory and simulation methods for RF scattering.
- Developed and marketed new research ideas to DARPA, ARPA-E, and other funding agencies.

Intern, FastSoft (now Akamai) *Summer 2007*
Developed theory and implementation of new TCP algorithms in FreeBSD kernel.
Developed infrastructural applications to streamline code verification.

Skills	Embedded systems design, prototyping, including x86 assembly language programming and VHDL experience (Caltech EE/CS 5x). Reverse engineering.
	Numerical electromagnetic algorithm development and implementation (FDTD, RCWA, DEC-FEM).
	Computational geometry, 3D geometry processing, OpenGL visualization, and algorithm implementation.
	Emphasis on fast and robust numerical software, high performance computing, and careful implementation of low level primitives (Lapack contributor).

Selected patents

1. "Congestion window control based on queuing delay and packet loss," US Patent 8,514,715 (2013).

2. "Multiband radio frequency (RF) energy harvesting with scalable antenna," US9935370B2.

3. "Passive radiation dry cooling module/system using meta-material," US10060686B2.

4. "System and method for remotely determining local operating environment of a refrigerant condenser unit," US2017284720A1.

5. "Radiative cooling panels for spacecraft," US20170297750A1.

6. "System and method for remotely inferring characteristics of thermostat-controlled appliances," US20160299038A1.

7. "Metamaterial-based phase shifting element and phased array," US10355356B2.

8. "Producing passive radiative cooling panels and modules," US20160362807A1.

9. "Metamaterial-based object-detection system," US20160011307A1.

10. "Deployable phased array antenna assembly," US10062951B2.

11. "Solar receiver with metamaterials-enhanced solar light absorbing structure," US10288323B2.

12. "Metamaterials-enhanced passive radiative cooling panel," US9927188B2.

13. "Metamaterial phased array for hyperthermia therapy," US20160166843A1.

14. "Thermal sensor with infrared absorption membrane including metamaterial structure," US9404804B1.

15. "Dithering methods and apparatus for wearable display device," US10444419B2.

16. "Outcoupling grating for augmented reality system," US10073267B2.

17. "Eyepiece for virtual, augmented, or mixed reality systems," US10451799B2.

18. "Waveguides having reflective layers formed by reflective flowable materials," US10436968B2.

19. 'Eyepieces for augmented reality display system," US20190187474A1.

20. 'Methods and apparatuses for reducing stray light emission from an eyepiece of an optical imaging system," US20190094551A1.

21. "Waveguides having integrated spacers, waveguides having edge absorbers, and methods for making the same," WO2019195193A1.

22. "Waveguides with integrated optical elements and methods for making the same," WO2019195174A1.

23. "Diffractive eyepiece," WO2018039277A9.

Selected papers

1. Z. Lin, V. Liu, R. Pestourie, S. G. Johnson, "Topology optimization of freeform large-area metasurfaces," Optics Express **27** (11), 15765-15775 (2019).

2. S. Verweij, V. Liu, S. Fan, "Accelerating simulation of ensembles of locally differing optical structures via a Schur complement domain decomposition," Optics Letters **39** (22), 6458-6461 (2014).

3. J. R. Piper, V. Liu, S. Fan, "Total absorption by degenerate critical coupling," Applied Physics Letters **104** (25), 251110 (2014).

4. K. X. Wang, Z. Yu, V. Liu, M. L. Brongersma, T. F. Jaramillo, S. Fan, "Nearly Total Solar Absorption in Ultrathin Nanostructured Iron Oxide for Efficient Photoelectrochemical Water Splitting," ACS Photonics **1** (3), 235-240 (2014).

5. V. Liu and S. Fan, "Compact bends for multi-mode photonic crystal waveguides with high transmission and suppressed modal crosstalk," Optics Express **21** (7), 8069-8075 (2013).

6. V. Liu, D. A. B. Miller, S. Fan, "Highly Tailored Computational Electromagnetics Methods for Nanophotonic Design and Discovery," Proceedings of the IEEE **101** (2), 484-493 (2013).

7. V. Liu, D. A. B. Miller, S. Fan, "Ultra-compact photonic crystal waveguide spatial mode converter and its connection to the optical diode effect," Optics Express **20** (27), 28388-28397 (2012).

8. V. Liu and S. Fan, "S4: A free electromagnetic solver for layered periodic structures," Computer Physics Communications **183** (10), 2233-2244 (2012).

9. K. X. Wang, Z. Yu, V. Liu, Y. Cui, S. Fan, "Absorption enhancement in ultrathin crystalline silicon solar cells with antireflection and light-trapping nanocone gratings," Nano Letters **12** (3), 1616-1619 (2012).

10. V. Liu and S. Fan, "Efficient computation of equifrequency surfaces and density of states in photonic crystals using Dirichlet-to-Neumann maps," Journal of the Optical Society of America B **28** (8), 1837-1843 (2011).

11. V. Liu, Y. Jiao, D. A. B. Miller, S. Fan, "Design methodology for compact photonic-crystal-based wavelength division multiplexers," Optics Letters **36** (4), 591-593 (2011).

12. V. Liu, M. Povinelli, S. Fan, "Resonance-enhanced optical forces between coupled photonic crystal slabs," Optics Express **17** (24), 21897-21909 (2009).

13. Z. Zhang, L. Yang, V. Liu, T. Hong, K. Vahala, A. Scherer, "Visible submicron microdisk lasers," Applied Physics Letters **90**, 111119 (2007)

Hobbies

- Woodworking: I built my own lathe, shavehorse, and some household furniture.

- Primitive technology: I build my own bows and arrows.

- Numerical and matrix analysis: I work on advancing the state-of-the-art in matrix eigensolvers in my free time.

- Computational geometry: I stay up-to-date with the latest graphics research and I am working on a geometry kernel for my personal CAD software.