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EDUCATION	<p><b>Ph.D. in Electrical Engineering</b> (advisor: Prof. Shanhui Fan) <span style="float: right;">2013</span>  <i>Stanford University</i>            Dissertation [<a href="#">link</a>]:            “3D Finite-Difference Frequency-Domain Method for Plasmonics and Nanophotonics”</p> <p><b>M.S. in Electrical Engineering</b> <span style="float: right;">2007</span>  <i>Stanford University</i></p> <p><b>B.S. in Physics &amp; Mathematics (double major)</b> <span style="float: right;">2001</span>  <i>Seoul National University</i></p>	
ACADEMIC EXPERIENCE	<p><b>Applied Mathematics Instructor</b> <span style="float: right;">2015–present</span>  <i>Department of Mathematics, Massachusetts Institute of Technology</i></p> <p><b>Postdoctoral Associate</b> (mentor: Prof. Steven G. Johnson) <span style="float: right;">2015–present</span>  <i>Department of Mathematics, Massachusetts Institute of Technology</i></p> <p><b>Postdoctoral Scholar</b> (mentor: Prof. Shanhui Fan) <span style="float: right;">2013–2015</span>  <i>Department of Electrical Engineering, Stanford University</i></p>	
TEACHING EXPERIENCE	<p><b>Instructor of 18.335: Introduction to Numerical Methods</b> <span style="float: right;">springs 2016–2018</span>  <i>Department of Mathematics, Massachusetts Institute of Technology</i></p> <ul style="list-style-type: none"> <li>• Course on theory and techniques of numerical linear algebra</li> <li>• Implement numerical algorithms in MATLAB (2016) and Julia (2017–18)</li> <li>• Large graduate-level class (~40 students)</li> </ul> <p><b>Instructor of EE 256: Numerical Electromagnetics</b> <span style="float: right;">spring 2014</span>  <i>Department of Electrical Engineering, Stanford University</i></p> <ul style="list-style-type: none"> <li>• Course on time- and frequency-domain Maxwell’s equations solvers</li> <li>• Rated by students as one of the 10 best EE courses (evaluation: 4.82/5.00)</li> </ul>	
INDUSTRY EXPERIENCE	<p><b>Software Engineer</b> <span style="float: right;">2001–2004</span>  <i>Park Systems, Suwon, South Korea</i></p> <p>Developed the following software for scanning probe microscopes (SPMs):</p> <ul style="list-style-type: none"> <li>• Data acquisition software on Texas Instruments’ digital signal processor in C</li> <li>• SPM head control software on Microsoft Windows in C++ (VC++)</li> <li>• Image editing software (similar to Photoshop) in Java (J2SE)</li> </ul>	
HONORS & AWARDS	<p>Samsung Scholarship (USD 50,000/year), <i>Samsung Scholarship Foundation</i> <span style="float: right;">2006–2011</span></p> <p>Summa cum laude graduate, <i>Seoul National University</i> <span style="float: right;">2001</span></p> <p>Bronze prize, Collegiate Mathematics Competition, <i>Korean Mathematical Society</i> <span style="float: right;">1999</span></p> <p>Silver medal, Korean Mathematical Olympiad (KMO), <i>Korean Mathematical Society</i> <span style="float: right;">1994</span></p>	
PATENT APPLICATIONS	<p><u>W. Shin</u>, S. Fan. “Simulation of phenomena characterized by partial differential equations.” Under review by USPTO (application number US 13/744,999) [<a href="#">link</a>].</p>	

**Computational Techniques**

5. W. Shin, D. Liu, S. G. Johnson. “Fixed-point formulation of the steady-state *ab initio* laser theory for solution by a black-box Maxwell solver.” *In preparation*.
4. N. Zhao, S. Verweij, W. Shin, S. Fan. “Accelerating convergence of an iterative solution of finite difference frequency domain problems via Schur complement domain decomposition.” *Optics Express* **26** (2018): 16925–39 [[link](#)].
3. Y. Shi, W. Shin, S. Fan. “Multi-frequency finite-difference frequency-domain algorithm for active nanophotonic device simulations.” *Optica* **3** (2016): 1256–59 [[link](#)].
2. W. Shin, S. Fan. “Accelerated solution of the frequency-domain Maxwell’s equations by engineering the eigenvalue distribution of the operator.” *Optics Express* **21** (2013): 22578–95 [[link](#)].
1. W. Shin, S. Fan. “Choice of the perfectly matched layer boundary condition for frequency-domain Maxwell’s equations solvers.” *Journal of Computational Physics* **231** (2012): 3406–31 [[link](#)].

**Nanophotonic Component Designs**

9. R. Pestourie, C. Pérez-Arancibia, Z. Lin, W. Shin, F. Capasso, S. G. Johnson. “Inverse design of large-area metasurfaces.” *Submitted*.
8. Y. Büyükalp, P. B. Catrysse, W. Shin, S. Fan. “Planar, ultra-thin, subwavelength spectral light separator for efficient, wide-angle spectral imaging.” *ACS Photonics* **4** (2017): 525–35 [[link](#)].
7. S. A. Khan, C.-M. M. Chang, Z. Zaidi, W. Shin, Y. Shi, A. K. Ellerbee Bowden, O. Solgaard. “Metal-insulator-metal waveguides for particle trapping and separation.” *Lab on a Chip* **16** (2016): 2302–8 [[link](#)].
6. A. Mahigir, P. Dastmalchi, W. Shin, S. Fan, G. Veronis. “Plasmonic coaxial waveguide-cavity devices.” *Optics Express* **23** (2015): 20549–62 [[link](#)].
5. Y. Büyükalp, P. B. Catrysse, W. Shin, S. Fan. “Spectral light separator based on deep-sub-wavelength resonant apertures in a metallic film.” *Applied Physics Letters* **105** (2014): 011114 [[link](#)].
4. T. Liu\*, Y. Shen\*, W. Shin\*, Q. Zhu, S. Fan, C. Jin. “Dislocated double-layer metal gratings: an efficient unidirectional coupler.” *Nano Letters* **14** (2014): 3848–54 [[link](#)] (\***co-first authors**).
3. W. Shin, W. Cai, P. B. Catrysse, G. Veronis, M. L. Brongersma, S. Fan. “Broadband sharp 90-degree bends and T-splitters in plasmonic coaxial waveguides.” *Nano Letters* **13** (2013): 4753–58 [[link](#)].
2. W. Cai, W. Shin, S. Fan, M. L. Brongersma. “Elements for plasmonic nanocircuits with three-dimensional slot waveguides.” *Advanced Materials* **22** (2010): 5120–24 [[link](#)].
1. L. Verslegers, P. Catrysse, Z. Yu, W. Shin, Z. Ruan, S. Fan. “Phase front design with metallic pillar arrays.” *Optics Letters* **35** (2010): 844–46 [[link](#)].

**Fundamental Physics**

4. W. Shin, S. Fan. “Unified picture of modal loss rates from microwave to optical frequencies in deep-subwavelength metallic structures: A case study with slot waveguides.” *Applied Physics Letters* **107** (2015): 171102 [[link](#)].
3. A. Raman, W. Shin, S. Fan. “Metamaterial band theory: fundamentals & applications.” *Science China Information Sciences* **56** (2013): 1–14 [[link](#)].
2. A. Raman, W. Shin, S. Fan. “Upper bound on the modal material loss rate in plasmonic and metamaterial systems.” *Physical Review Letters* **110** (2013): 183901 [[link](#)].
1. W. Shin, A. Raman, S. Fan. “Instantaneous electric energy and electric power dissipation in dispersive media.” *Journal of the Optical Society of America B* **29** (2012): 1048–54 [[link](#)].

- CONFERENCE ORAL PRESENTATIONS
5. W. Shin, D. Liu, S. G. Johnson. “Fixed-point iterative solution of the microlaser mode equation using a black-box Maxwell’s equations solver via implicit Newton step calculation.” *15th Copper Mountain Conference on Iterative Methods*, Copper Mountain, Colorado. Mar. 2018.
  4. W. Shin, W. Cai, P. B. Catrysse, G. Veronis, M. L. Brongersma, S. Fan. “Plasmonic nano-coaxial waveguides for 90-degree bends and T-splitters.” *CLEO*, San Jose, California. June 2013.
  3. W. Shin, S. Fan. “Choice of the perfectly matched layer boundary condition for iterative solvers of the frequency-domain Maxwell’s equations.” *28th Annual Review of Progress in Applied Computational Electromagnetics*, Columbus, Ohio. Apr. 2012.
  2. W. Shin, S. Fan. “Accelerated solution of the frequency-domain Maxwell’s equations by engineering the spectrum of the operator using the continuity equation.” *12th Copper Mountain Conference on Iterative Methods*, Copper Mountain, Colorado. Mar. 2012.
  1. W. Shin, S. Fan. “Choice of the perfectly matched layer boundary condition for iterative solvers of the frequency-domain Maxwell’s equations.” *SPIE Photonics West*, San Francisco, California. Jan. 2012.
- CONFERENCE POSTER PRESENTATIONS
3. W. Shin, A. Raman, S. Fan. “Upper bound of Ohmic loss rates in deep-subwavelength metallic structures: from microwave to optical frequencies.” *AFOSR Annual Review of EM Contractors*, Arlington, Virginia. Jan. 2017.
  2. W. Shin, A. Raman, S. Fan. “Upper bound on the modal material loss rate in plasmonic and metamaterial systems.” *First Year Review of AFOSR MURI: Template-Directed Directionally Solidified Eutectic Metamaterials*, Dayton, Ohio. Oct. 2013.
  1. W. Shin, A. Raman, S. Fan. “Instantaneous electric energy density and power dissipation density in dispersive media.” *IONS NA-3*, Stanford, California. Oct. 2011.
- ACADEMIC SOFTWARE DEVELOPMENT
- MaxwellFDFD** developed in *MATLAB* (since 2012) <https://github.com/wsshin/maxwelldfd>  
*MaxwellFDFD* is a *MATLAB* package that solves the frequency-domain Maxwell’s equations. It constructs a system of linear equations out of Maxwell’s equations by the finite-difference frequency-domain (FDFD) method, and hence the name MaxwellFDFD. The constructed system is solved by *MATLAB*’s built-in direct solvers. MaxwellFDFD has the following major features:
- Adaptive nonuniform grid generation aligned with object boundaries
  - Waveguide mode solver
  - Electric (**J**) and magnetic (**M**) current sources
  - PEC, PMC, and Bloch-periodic boundary conditions with PML
  - Total-field/scattered-field (TF/SF) method
- FD3D** developed in *C* and *Python* (since 2008) <https://github.com/wsshin/fd3d>  
*FD3D* is a parallelized computational kernel for solving the frequency-domain Maxwell’s equations. It is a companion program of MaxwellFDFD: users can easily generate the input files for *FD3D* from MaxwellFDFD, and import the solution calculated by *FD3D* into MaxwellFDFD for further analysis. *FD3D* uses the PETSc library for distributed allocation of matrices and vectors, and it runs on any LINUX clusters that support MPI communication. Using the various techniques developed throughout my doctoral research, *FD3D* achieves more than 300-fold speedup compared to conventional iterative solvers of the frequency-domain Maxwell’s equations.
- MaxwellFDM.jl** developed in *Julia* (since 2016) <https://github.com/wsshin/MaxwellFDM.jl>  
*MaxwellFDM.jl* is a single package that aims to eliminate the inconvenience of dealing with two separate programs—MaxwellFDFD and *FD3D*—for 3D simulation. It is being developed in *Julia*, a new open-source programming language that is as easy to use as *MATLAB* while as performant

as C thanks to the powerful type inference system. MaxwellFDM.jl is being developed as the *ultimate* FDFD solver that fulfills all the major user requests collected throughout my doctoral and postdoctoral research. Most notably, it finally supports the full permittivity tensor for modeling anisotropic materials, and also subpixel smoothing for accurate modeling of curved surfaces on the rectangular finite-difference grid.

**SALTBase.jl** *developed in Julia* (since 2017) <https://github.com/wsshin/SALTBase.jl>  
*SALTBase.jl* is a framework for building a software package to simulate multimode nanolasers. It aims to solve the laser mode equations called the steady-state *ab initio* laser theory (SALT)—the steady-state version of the semiclassical Maxwell–Bloch equations. SALTBase.jl implements my original *implicit Newton step calculation* method, which enables one to use any black-box Maxwell solver as the computational kernel for building a SALT solver scalable to 3D problems.

**MaxwellSALT.jl** *developed in Julia* (since 2017) <https://github.com/wsshin/MaxwellSALT.jl>  
*MaxwellSALT.jl* is a simple SALT solver package built on top of SALTBase.jl, with MaxwellFDM.jl as a Maxwell solver. It demonstrates SALTBase.jl's capability to accept any black-box Maxwell solver as the computational kernel.

**jemdoc+MathJax** *developed in Python* (since 2013) [https://github.com/wsshin/jemdoc\\_mathjax](https://github.com/wsshin/jemdoc_mathjax)  
*jemdoc* is an open-source website generator that is widely used in the academia for creating personal websites. *MathJax* is an open-source project founded by AMS and SIAM for displaying  $\LaTeX$  equations on webpages. Combining these two existing platforms, I have developed *jemdoc+MathJax*, an open-source program for easily creating academic websites containing beautifully rendered  $\LaTeX$  equations. See my interview with MathJax.org about jemdoc+MathJax [\[link\]](#).

## REFERENCES

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