

Curriculum Vitae
Cody Ryan Scarborough
Electrical Engineering Ph.D. Candidate

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Education

Graduate GPA: 4.00 / Undergraduate GPA: 3.92

The University of Michigan – August 2017 to August 2022

Doctor of Philosophy in Electrical Engineering

Advisor: Dr. Anthony Grbic

The University of Texas at Austin – August 2013 to May 2017

Bachelor of Science in Electrical Engineering – Magna Cum Laude

Journal Publications

- C. Scarborough and A. Grbic, “Efficient Computation of Spatially-Discrete Traveling-Wave Modulated Structures,” *IEEE Transactions on Microwave Theory and Techniques*, submitted April 2022.
- C. Scarborough, Z. Wu, and A. Grbic, “Efficient Computation of Spatially-Discrete Traveling-Wave Modulated Structures,” *IEEE Transactions on Antennas and Propagation*, vol. 69, no. 12, pp. 8512-8525, December 2021.
- Z. Wu, C. Scarborough, and A. Grbic, “Space-Time-Modulated Metasurfaces with Spatial Discretization: Free-Space N-Path Systems,” *Physical Review Applied*, vol. 14, no. 6, pp. 64060-64079, December 2020.
- C. Scarborough and A. Grbic, “Accelerated N-Path Network Analysis Using the Floquet Scattering Matrix Method,” in *IEEE Transactions on Microwave Theory and Techniques*, vol. 68, no. 4, pp. 1248-1259, April 2020.

Conferences

- C. Scarborough, Q. Chen, Z. Wu, and A. Grbic, “Simulating Space-Time Structures using Commercial Solvers,” *2022 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting*, Denver, CO, USA, 2022, under review.
- C. Scarborough and A. Grbic, “Spatially-Discrete Traveling-Wave Modulation: A Higher-Order Space-Time Symmetry,” in *The 16th European Conference on Antennas and Propagation (EuCAP 2022)*, 2022.

- C. Scarborough and A. Grbic, "Generalized Eigenvalue Problem for Spatially-Discrete Traveling-Wave-Modulated Circuit Networks," *2021 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting*, Marina Bay Sands, Singapore, 2021.
- C. Scarborough and A. Grbic, "Efficient Subharmonic Frequency Conversion Using Space-Time Induced Bound States in the Continuum," in *2021 15th International Congress on Artificial Materials for Novel Wave Phenomena (Metamaterials)*, New York, NY, USA, 2021.
- C. Scarborough and A. Grbic, "The Interpath Relation for Spatially-Discrete Traveling-Wave Modulated Structures," in *The 15th European Conference on Antennas and Propagation (EuCAP 2021)*, 2021.
- C. Scarborough and A. Grbic, "A Novel Boundary Condition for Spatially-Discrete Traveling-Wave Modulation," *Waves in Time-Varying Media Workshop Series*, London, UK, 2021.
- C. Scarborough and A. Grbic, "Modified Floquet Boundary Condition for Open Boundary Problems with N-Path Symmetry," in *2020 14th International Congress on Artificial Materials for Novel Wave Phenomena (Metamaterials)*, New York, NY, USA, 2020.
- C. Scarborough and A. Grbic, "Coupled Line Unit Cell for Independent Control of Even and Odd Mode Phase Delays," *2020 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting*, Montréal, Québec, Canada, 2020.
- Z. Wu, C. Scarborough, and A. Grbic, "A Spatio-Temporally Modulated Metasurface as a Free-Space N-Path System," in *The 14th European Conference on Antennas and Propagation (EuCAP 2020)*, 2020.
- C. Scarborough and A. Grbic, "Modified Floquet Scattering Matrix Method for Solving N-path Networks," *2019 IEEE International Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting*, Atlanta, GA, USA, 2019.
- A. Grbic, C. Scarborough, F. Salas and Z. Wu, "Time-Modulated Metamaterials and Metasurfaces: Design and Analysis," *2019 International Conference on Electromagnetics in Advanced Applications (ICEAA)*, Granada, Spain, 2019.
- C. Scarborough and A. Grbic, "N-Path Network Analysis using the Floquet Scattering Matrix Method," *2019 US National Committee of URSI National Radio Science Meeting (USNC-URSI NRSM)*, Boulder, CO, USA, 2019.
- C. Scarborough, K. Venugopal, A. Alkhateeb, and R. W. Heath Jr., "Beamforming in Millimeter Wave Systems: Prototyping and Measurement Results," *The 88th IEEE Vehicular Technology Conference, VTC2018-Fall*, 2018.
- A. Kumar, C. Scarborough, A. Yilmaz, and M. Orshansky, "Efficient simulation of EM side-channel attack resilience," *2017 IEEE/ACM International Conference on Computer-Aided Design (ICCAD)*, 2017.

Patents

Provisional Patent: C. Scarborough and A. Grbic, “Efficient Computation of Spatially-Discrete Traveling-Wave Modulated Structures”, Serial No. 63/238379, Filed August 30, 2021.

Awards / Recognition

Finalist for Best Electromagnetics Paper Award at EuCAP 2022 – Spring 2022

I have been nominated to compete for the Best Electromagnetics Paper Award at 16th European Conference on Antennas and Propagation (EuCAP 2022) for my paper entitled “Spatially-Discrete Traveling-Wave Modulation: A Higher-Order Space-Time Symmetry.” My paper is one of five selected to compete in a poster presentation before a panel of judges.

Best Student Paper Award at Metamaterials 2021 – Summer 2021

This award was presented to me at the 15th International Congress on Artificial Materials for Novel Wave Phenomena (Metamaterials) for my paper entitled “Efficient Subharmonic Frequency Conversion Using Space-Time Induced Bound States in the Continuum.” My paper was one of five selected to compete in a poster presentation before a panel of judges.

Finalist for Best Experimental Poster at Waves in Time-Varying Media – Summer 2021

My paper entitled “A Novel Boundary Condition for Spatially-Discrete Traveling-Wave Modulation” was awarded third place at the Waves in Time-Varying Media Workshop Series. The award was sponsored by the Optical Society of America (OSA) intended to recognize research efforts with significant practical impact.

Honorable Mention in the Graduate Student Instructor Award – Spring 2021

The Graduate Student Instructor Award is given to teaching assistants who demonstrate exceptional commitment to the learning process. I was selected for an honorable mention due to my dedication to the students in the course, developing labs that could be completed in a hybrid format during the COVID-19 pandemic.

Best Student Paper Award at EuCAP 2021 – Spring 2021

This award was presented to me at the 15th European Conference on Antennas and Propagation (EuCAP 2021) for my paper entitled “The Interpath Relation for Spatially-Discrete Traveling-Wave Modulated Structures.” My paper was one of five selected to compete in a poster presentation before a panel of judges.

Finalist for Best Electromagnetics Paper Award at EuCAP 2021 – Spring 2021

My paper entitled “The Interpath Relation for Spatially-Discrete Traveling-Wave Modulated Structures” was one of the five papers selected to compete for this award in a poster presentation at the 15th European Conference on Antennas and Propagation (EuCAP 2021).

Exceptional Student Contributions Award at Metamaterials 2020 – Fall 2020

This award, sponsored by the Royal Society of Chemistry, was given to two students at the 14th International Congress on Artificial Materials for Novel Wave Phenomena (Metamaterials). I was given the award for my paper titled “Modified Floquet Boundary Condition for Open Boundary Problems with N-Path Symmetry.”

Finalist for Best Electromagnetics Paper Award at EuCAP 2020 – Spring 2020

My paper published in collaboration with Zhanni Wu entitled “A Spatio-Temporally Modulated Metasurface as a Free-Space N-Path System” was one of the five papers selected to compete for this award in a poster presentation at the 14th European Conference on Antennas and Propagation (EuCAP 2020).

Honorable Mention for Best Student Paper Competition at IEEE Symposium on Antennas and Propagation – Summer 2019

I received this award for my paper entitled “Modified Floquet scattering matrix method for solving N-path networks,” which I presented at the 2019 IEEE AP-S Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting in Atlanta, Georgia.

Applied Research Laboratories Honors Scholar Program – Fall 2015

Students who are accepted to the Honors Scholar Program take on a challenging technical project, under the supervision of a mentor, to address a practical problem. My project was to develop a deployable package capable of evaluating an environment as a potential site for a GPS monitoring station.

Employment History

The University of Texas Computational Electromagnetics Group – January 2017 to August 2017

As an undergraduate researcher, I wrote a solver (in FORTRAN) to rapidly evaluate the radiation integral within the context of cryptographic integrated circuits. Using the computational resources at the Texas Advanced Computing Center, I parallelized my code amongst 4,000 cores to dramatically reduce the simulation time. Working with Dr. Ali Yilmaz and a graduate student in the cryptography community at the University of Texas, we developed a software which would determine the vulnerability of integrated cryptographic circuits to electromagnetic “side-channel” attacks. My contribution consisted of calculating the voltage signal induced across the terminals of a probe in the presence a cryptographic circuit while processing a carefully selected set of bytes.

Wireless Network and Comm. Group (WNCG) – May 2016 to January 2017

Under the supervision of Dr. Robert Heath Jr., I designed, developed, and implemented a hybrid beamforming 5G (60 GHz) wireless system with phased array antennas. I wrote code to electronically steer power radiated by the antenna array, in addition to designing a feedback protocol to share the channel measurements made by the receiving system with the transmission system.

Applied Research Labs (ARL) – May 2015 to May 2016

At Applied Research Labs I gained experience in the field of Global Navigation Satellite Systems (GNSS). Here I applied my knowledge of signal processing, programming and circuit design, as I collaborated with other engineers to develop a GNSS signal quality analyzer package. This position provided me with the opportunity to operate spectrum analyzers, perform multipath analysis, and develop code within the environment of a Linux operating system. The package required customized circuits, and as such I gained experience designing, ordering, printing, and soldering circuit boards.

Research Areas of Interest

Electromagnetics, Fields, and Waves

Electromagnetic theory, scattering from rough surfaces and random media, remote sensing, optical waves in crystals, electromagnetic metamaterials, microwave engineering/measurements, antennas and wireless propagation, computational electromagnetics, space-time modulation, synthetic aperture radar, classical optics.

Nonlinear Optical/Electronic Devices

Quantum theory of engineering materials, non-reciprocal devices, nonlinear optics, solid state electronic devices, high throughput nanopatterning techniques, nanofabrication of active metamaterials

Objective

As a tenure track faculty member in applied electromagnetics, I intend to apply my knowledge and skills to develop innovative electromagnetic technology that addresses modern challenges within wireless links. Beyond my role as a researcher, I aim to teach and inspire the next generation of engineers, preparing them for a future technological career in our interconnected society.