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JORDAN BUDHU

EDUCATION

Postdoctoral Research Fellow – Radiation Laboratory
University of Michigan
Since January 2019
Radiation Laboratory-Electromagnetic Metamaterials Laboratory
Principle Investigator Prof. Anthony Grbic

Doctor of Philosophy in Electrical Engineering- Physical and Wave Electronics
University of California, Los Angeles
Graduated—Fall 2018
UCLA Antenna, Research, Analysis, and Measurement Laboratory
Under Advisement of Prof. Yahya Rahmat-Samii

Master of Science in Electrical Engineering- Microwave and Antenna Engineering
California State University, Northridge
Graduated—May 2010 *with Distinction*
Under Advisement of Prof. Sembiam Rengarajan

Bachelor of Science in Electronics Engineering Technology
Devry University
Graduated—February 2006 *Magna Cum Laude*

AWARDS AND HONORS

Physical copy of all awards available upon request

- **2006 First Place Award / Undergraduate Senior Project**
- **2012 First Place Best Poster Award at the 2012 IEEE Coastal Los Angeles Class-Tech Meeting.**
- **2019 First Place USNC-URSI Ernst K. Smith Student Paper Competition Award**
- **2018 UCLA Henry Samueli School of Engineering Excellence in Teaching Award**
- **2010 UCLA Eugene Cota-Robles Fellowship**
- **2018 Teaching Assistant Consultant (EE Department Head TA)**
- **2013, 2017, 2018, and 2019 USNC-URSI National Radio Science Meeting Travel Fellowship Grant**
- **Member of the IEEE Antennas and Propagation Society (IEEE-APS)**
- **Member of the Bioelectromagnetics Society (BEMS)**

RESEARCH EXPERIENCE

Awards and Honors:

- First Place Undergraduate Senior Project Award
- First Place Best Poster Award at 2012 IEEE Coastal Los Angeles Meeting
- First Place 2019 USNC-URSI Ernst K. Smith Student Paper Competition Award
- 2010 UCLA Eugene Cota-Robles Fellowship
- UCLA Modern Microwave Antenna Measurements Short Course Certificate Holder

Postdoctoral Research – Metamaterials, Metasurfaces, Reflectarrays, Dielectric Resonator Antenna Coupled Infrared Photodetectors

Metamaterial based subwavelength textured reflectarray antennas which model mutual coupling rigorously within the homogenization limit. These structures offer superior performance and avoid any infinite array approximation or local periodicity assumptions. Multilayer, multiband, metasurface antennas which model rigorously the interelement coupling within layers and from layer to layer. These structures are designed via a coupled volume and surface integral equation system which is solved via the method of moments. Dielectric Resonator Antenna Coupled Infrared Photodetectors offer reduced detector dimensions while

keeping the radiation capture area large improving the overall signal to noise ratio.

Graduate Ph.D. Dissertation -- Numerical Synthesis Algorithms for Next Generation Spaceborne Wind Scatterometer and CubeSat Antennas
Two novel aperture type antennas, both for next-generation spaceborne applications, were designed. The first is a 3D printed, all-dielectric, inhomogeneous, shaped-lens antenna designed to produce a conical spinning high-directive beam. The scan is electronic from a ring of feeds located along the ring focus designed into the azimuthally symmetric lens. The antenna is proposed for use in a spaceborne scatterometer used to measure wind speeds upon the surface of the earth's oceans. The design requires the advent of a complex code hybridizing the Computational Electromagnetics method of Geometrical Optics with the optimization strategy of Particle Swarm Optimization. This code and its mathematical formulations, the resultant designs, and the measurements validating the codes and obtained designs. The second is a new novel dual-reflector Gregorian antenna system designed to meet the stringent requirements of the newly proposed CubeSat satellite paradigm by folding the optics into one of the most compact dual reflectors to date. This antenna design requires a complex computer code classified as a hybrid technique which combines the Method of Moments algorithm with the Particle Swarm Optimization. The dissertation includes the theory and mathematical formulations behind this algorithm, as well as the resultant designs and measurements

Graduate Masters Thesis – Investigations into Reflectarray Design Using the Infinite Array Approximation
When designing or analyzing a reflectarray antenna, the typical method used employs the infinite array approximation. This baseline analysis method was obtained by performing simulations using both a code I wrote for Reflectarray Analysis and Design using the Spectral Domain Method of Moments or SD-MoM and using the Electromagnetics Design and Analysis tool CST Microwave Studio. The obtained patterns for each antenna and each analysis technique were then plotted together to discern whether the techniques which employed the infinite array approximation employed in the SD-MoM code agreed with the baseline patterns obtained through CST MWS.

Undergraduate Senior Project – Automatic Automobile Oil Change System
Designed, programmed, and manufactured an automatic automobile oil-change system utilizing the HC12 microcontroller by Motorola. Software programming was done via the C language and also via the assembly programming language. The winner would receive a small monetary award and a plaque. ***My project won the first place award***.

TEACHING EXPERIENCE

Awards and Honors:

- 2018 Henry Samueli School of Engineering Excellence in Teaching Award
- Selected as 2018 Henry Samueli School of Engineering Department Teaching Assistant Consultant
- UCLA Teaching Academy Certificate Holder

University of Michigan **January 2020- May 2020**
LEO Intermittent Lecturer
Primary Instructor for Winter 2020 semester (EECS430 Wireless Link Design). Fundamentals of electromagnetic radiation propagation (near earth, troposphere, ionosphere, and indoor and urban); antenna parameters; practical antennas; link analysis, system noise; fading and multipath interference; applications. Course includes informative labs and a team project in practical wireless system design.

University of California Los Angeles **September 2018- December 2018**
Teaching Fellow
Teaching Fellow position for Fall 2018 quarter (EE101A Electromagnetic Wave). In the courses, was actively involved in the course preparations along with the professor of the course in which homework solution set preparation, problem suggestions, term project description contributions, and proctoring was privileged. Lead the discussion sessions in which problems to aid course material comprehension were worked through.

University of California Los Angeles **June 2018**
Awarded UCLA HSSEAS Excellence in Teaching Award
Awarded the Henry Samueli School of Engineering and Applied Science Excellence in Teaching Award. The recipient of this annual competitive award must be nominated by the professor of the course and 5 letters of recommendation written by 5 students and submitted to a department review panel. I won the award upon being nominated for excellence in Teaching for the EE101A Winter 2018 quarter. The letters of recommendation by the students were given to me upon approval from the department chair and they are available upon request.

University of California Los Angeles **September 2018- December 2018**
Teaching Assistant Consultant

Selected from a pool of over 150 TA's in the Electrical Engineering Department as the Departmental Head TA. The official title is Teaching Assistant Consultant. The description is to consult the departments TA's on how to be better TA's for their respective courses. Consulted the departments teaching assistants for the 2018-2019 Academic Year and was the teaching assistant for EE 495 Teaching Assistant Training Seminar course. This course is mandatory for all new TA's in the department.

University of California Los Angeles **January 2018- March 2018**
Teaching Associate
Teaching Associate position for Winter 2018 quarter (EE101A Electromagnetic Wave). In the courses, was actively involved in the course preparations along with the professor of the course in which homework solution set preparation, problem suggestions, term project description contributions, and proctoring was privileged. Lead the discussion sessions in which problems to aid course material comprehension were worked through.

University of California Los Angeles **March 2017- June 2017**
Teaching Associate
Teaching Associate position for Spring 2017 quarter for EE162A Communication Systems and Antennas. In this course, was actively involved in the course preparations along with the professor of the course in which homework solution set preparation, problem suggestions, term project description contributions, and proctoring was privileged. Lead the discussion sessions in which problems to aid course material comprehension were worked through.

University of California Los Angeles **January 2017- March 2017**
Teaching Associate
Teaching Associate position for Winter 2017 quarter for EE101B Electromagnetic Wave. In this course, was actively involved in the course preparations along with the professor of the course in which homework solution set preparation, problem suggestions, term project description contributions, and proctoring was privileged. Lead the discussion sessions in which problems to aid course material comprehension were worked through.

University of California Los Angeles **September 2015- January 2016**
Graduate Student Reader
Generated solutions and graded homework and midterms in the Graduate Advanced Engineering Electrodynamics EE260A course of 34 students. A Total of 7 assignment, 1 midterm, and 1 final exam.

University of California Los Angeles **September 2012-December 2012**
Teaching Assistant
Teaching Assistant position for Fall 2012 quarter for EE1 Electrical Engineering Physics. In EE1, worked with 2 other T.A.'s as the class had over 100 students, prepared HW solutions in conjunction with the other T.A.'s as well as leading 3 discussion courses along with 6 office hour offerings per week.

University of California Los Angeles **March 2012- June 2012**
Teaching Assistant
Teaching Assistant position for Spring 2012 quarter for EE162A Communication Systems and Antennas. In EE162A, was actively involved in the course preparations along with the professor of the course in which homework solution set preparation, problem suggestions, term project description contributions, and proctoring was privileged. Lead the discussion sessions in which problems to aid course material comprehension were worked through.

California State University Northridge **January 2010-July 2010**
Teaching Assistant
Teaching assistant for the course ECE 371 for Electromagnetic Fields and Wave I for the Spring semester. Graded all assignments, kept a grade book for each student in the course, gave a few homework help extra sessions as well as proctored the final exam.

Frog Tutoring **January 2017-Present**
Engineering, Physics, and Mathematics Tutor
Tutoring kids from K-12 all the way up to Graduate School in various subject areas such as Mathematics, Geometry, Physics, and Engineering.

BookAnyone Online Tutoring **June 2018-Present**
Advanced Math Science Engineering Tutor
Tutoring kids from K-12 all the way up to Graduate School in various subject areas such as Mathematics, Geometry, Physics, and Engineering.

Ingenius Academic Prep Mentoring **Jan 2019-Present**
Academic Mentor
Mentorship role in one-on-one project development with a student hand selected by their academic institution to participate in the program. An 8-week project is planned, executed, and presented by the student and I in complex engineering or computer science topics.

INDUSTRY EXPERIENCE

University of Michigan **January 2019—Present**
Research Fellow, Electromagnetic Metamaterials Lab, Radiation Laboratory
Postdoctoral Research Fellow. Metamaterial Design, LWIR focal plane array design, Dielectric Resonator Antenna Design, Anisotropic Inhomogeneous Metamaterial Lens Design. Reflectarray Metasurface Designs.

NASA Jet Propulsion Laboratory **June 2012—September 2012**
Summer Intern III, Spacecraft Antennas Group
Continued Support for Data Analysis of the Dual-Polarized Reflectarray Antenna for Spacecraft Antennas in readiness for an upcoming Technical Design Review. Wrote multiple data analysis routines for Antenna Beam Pointing Error Analysis, Antenna Deformation Error Analysis, and Agreement between Simulation and Measurement Data Investigations. These programs would take simulation data with all known errors considered and compare with the actual measured breadboard data in order to determine where the unknown, if any, possible sources of simulation error in the computer analysis tool may lie. This enforced confidence in current and future applications of the in-house tool.

NASA Jet Propulsion Laboratory **July 2011—October 2011**
Summer Intern III, Spacecraft Antennas Group
Responsible for running simulations and writing programs to make comparisons with measurements of Dual-Polarized Reflectarray Antenna for Spacecraft Applications. This program performed various coordinate transformations to align data from four coordinate systems based on Metrology Data, the Antenna Range C.S., the Feed C.S., The Array C.S. and the Support Structure C.S.. Also helped with coordinating the project summary for next stage funding.

Meggitt Safety System Inc. **October 2006—September 2010**
Software Engineer
Design, Implement, and Test DO-178B compliant embedded software for avionics platforms using the C programming language and Model based programming (SCADE tool). Wrote requirements documents, validation and verification documents, and test cases. Implemented entire projects from customer requirements to deliverable software all while producing required documents to become certified with the FAA. Worked on projects for Boeing, Airbus, LeerJet, and Bombardier.

Lucix Cooperation **March 2006—October 2006**
Engineering Technician
Testing of microwave phase locked oscillators and test/tuning of microwave hybrid amplifiers. Network analyzers and S-parameters were used to tune amplifiers to customers specifications. Tuned for Gain, Return Loss, Noise Figure, Power, etc.

Meggitt Safety Systems Inc. **November 2005— March 2006**
Engineer Intern
Interning as an Engineer assisting coworkers on various projects. Involved in designing and Troubleshooting systems for the company.

PUBLICATIONS

A copy of the following papers are available upon request.

Journal Papers:

Jordan Budhu and Yahya Rahmat-Samii, Richard E. Hodges, Douglas C. Hoffman, Donald F. Ruffatto, Kalind C. Carpenter, "Three-Dimensionally Printed, Shaped, Engineered Material Inhomogeneous Lens Antennas for Next-Generation Spaceborne Weather Radar Systems," in IEEE Antennas and Wireless Propagation Letters, vol. 17, no. 11, pp. 2080-2084, Nov. 2018.

Jordan Budhu and Yahya Rahmat-Samii, "A Novel and Systematic Approach to Inhomogeneous Dielectric Lens Design based on Curved Ray Geometrical Optics and Particle Swarm Optimization," – IEEE Transactions on Antennas and Propagation, Vol. 67, No. 06., June 2019.

Jordan Budhu and Yahya Rahmat-Samii, "A Diagnostics Tool For 3D Printed Inhomogeneous Dielectric Lenses Misprinted Due to Fabrication Tolerances," – Accepted for publication in IEEE Antennas and Propagation Magazine.

Jordan Budhu and Anthony Grbic, "Design of Metasurface-Based Reflectarray Antennas Including Rigorous Mutual Coupling," – Under Review in IEEE Transactions on Antennas and Propagation

Conference Papers:

Jordan Budhu and Yahya Rahmat-Samii, "Understanding the Appearance of Specular Reflections in Offset Fed Reflectarray Antennas." – Presented at the Reflectarray Antennas special session of the IEEE Antennas and Propagation Society (APS) Conference of 2011 in Spokane, Washington.

Jordan Budhu and Yahya Rahmat-Samii, "Characterizing Specular Reflections in Offset Fed Reflectarray Antennas." – Electrical Engineering Department Annual Research Review, University of California, Los Angeles, March 2011

Jordan Budhu and Yahya Rahmat-Samii, " Offset Fed Reflectarray Antennas: A Closer Look At How To Remedy Specular Reflection." – IEEE Coastal Los Angeles Annual Meeting, October 2012. *Won First Place Prize for Best Poster*

Jordan Budhu and Yahya Rahmat-Samii, "An Efficient Spectral Domain Method of Moments for Reflectarray Antennas using a Customized Impedance Matrix Interpolation Scheme." – Presented at the Numerical Methods Session of the 2013 National Radio Science Meeting (NRSM) in Boulder, Colorado.

Jordan Budhu and Yahya Rahmat-Samii, "On Efficiency Improvements for the Spectral Domain Method of Moments Through Various Schemes of Impedance Matrix Interpolations." – presented at the July 2013 IEEE Antennas and Propagation Society Annual Meeting in Chicago, Illinois.

Jordan Budhu and Yahya Rahmat-Samii, "Synthesizing Thin Dielectric Lenses for Conical Scanning Beams: A Hybrid Numerical Algorithm." – Presented at the Emerging Computation Methods Special Session of the 2017 National Radio Science Meeting (NRSM) in Boulder, Colorado.

Jordan Budhu and Yahya Rahmat-Samii, "Synthesis of 3D-Printed Dielectric Lens Antennas Via Optimization of Geometrical Optics Ray Tracing." – presented at the July 2017 IEEE Antennas and Propagation Society Annual Meeting in San Diego, California.

Rahmat-Samii, Y., Kovitz, J.M., **Budhu, J.**, Manohar, V., "A Novel Near-field Gregorian Reflectarray Antenna Design with a Compact Deployment Strategy for High Performance CubeSats", AMTA Conference, Atlanta, GA, October 2017

Jordan Budhu and Yahya Rahmat-Samii, "Shaped, Thin Luneburg-Like Lens Antennas Optimized for Conical beam Scans with Ring-Type Focus."– Electrical Engineering Department Annual Research Review, University of California, Los Angeles, March 2017

Jordan Budhu and Yahya Rahmat-Samii, " Shaped-Profiled and Material-Engineered Inhomogeneous Lens Antennas: GO Curved Ray Tracing and Aperture Fields." – presented at the January 2018 National Radio Science Meeting (NRSM) in Boulder, Colorado.

Jordan Budhu and Yahya Rahmat-Samii, "A Novel GO-PSO Algorithm for Designing 3D-Printed Optimized Pixelized Inhomogeneous and Shaped-Profiled Lens Antennas", AMTA Conference, Atlanta, GA, October 2018

Vignesh Manohar, **Jordan Budhu**, and Yahya Rahmat-Samii, "Representative Low-Profile Gregorian Reflector Antenna Designs with a Compact Depolyment Strategy for Emerging CubeSats", – presented at the January 2019 National Radio Science Meeting (NRSM) in Boulder, Colorado

Jordan Budhu and Yahya Rahmat-Samii, "A New 3D-Printed Electronically Scanned Spinning Spot Beam Inhomogeneous Dielectric Lens Antenna for Spaceborne Wind Scatterometer Weather Radar Satellites", – presented at the January 2019 National Radio Science Meeting (NRSM) in Boulder, Colorado. *First Place Award Student Paper Competition*

Jordan Budhu and Yahya Rahmat-Samii, " A Novel Diagnostics Method for Determining the Unknown Permittivity Profile of 3D Printed Lenses." – presented at the July 2019 IEEE Antennas and Propagation Society Annual Meeting in Atlanta, Georgia.

Yahya Rahmat-Samii, **Jordan Budhu**, Richard E. Hodges, D. C. Hoffman, and Don Ruffatto, " A Novel 60-cm Nonsherical 3-D Printed Voxelized Lens Antenna: Design, Fabrication and Measurement." – presented at the July 2019 IEEE Antennas and Propagation Society Annual Meeting in Atlanta, Georgia.

Alireza Kazemi, Qingyuan Shu, Vinita Dahiya, Zahra Taghipour, Pablo Paradis, Christopher Ball, Theodore J. Ronningen, Stefan Zollner, Steven M. Young, **Jordan Budhu**, Kevin A. Grossklaus, Thomas E. Vandervelde, Anthony Grbic, Sanjay Krishna, "Subwavelength antimonide infrared detector coupled with dielectric resonator antenna," Proc. SPIE 11002, Infrared Technology and Applications XLV, 1100221 (7 May 2019).

Jordan Budhu and Anthony Grbic, "A Rigorous Approach to Designing Reflectarrays", --presented at the 23rd International Conference on Electromagnetics and Communications (ICECOM) in Dubrovnik, Croatia, October 2019.

Jordan Budhu, Anthony Grbic, and Eric Michielssen, "Design of Multilayer, Dualband Metasurface Reflectarrays" – presented at the March 2020 European Conference on Antennas and Propagation (EuCAP) Annual Meeting in Copenhagen, Denmark.

INVITED TALKS

Jordan Budhu and Yahya Rahmat-Samii, "Directivity Enhancement of Offset Fed Reflectarray Antennas." –presented at the Electrical Engineering Department Annual Research Review, University of California, Los Angeles, March 2012

Jordan Budhu and Yahya Rahmat-Samii, "Next Generation Spaceborne Wind Scatterometer Weather Radar Satellite Antenna." –presented at the March 2018 National Science Foundation (NSF) California Academic Alliance Retreat in Berkeley, California.

Jordan Budhu and Yahya Rahmat-Samii, " 3D-Printed, Lightweight, Shaped and Engineered Material, Inhomogeneous Lens Antennas for Next Generation Spaceborne Weather Radar Satellites." –presented at the Electrical Engineering Department Annual Research Review, University of California, Los Angeles, March 2018

Jordan Budhu and Yahya Rahmat-Samii, "Next Generation Spaceborne Wind Scatterometer and CubeSat Antennas: Lightweight 3D Printed Inhomogeneous Lens Antennas and Dual Reflectarray Antennas." –presented at the University of Michigan Radiation Laboratory Seminar, Ann Arbor, June 2018.

Jordan Budhu and Yahya Rahmat-Samii, "Next Generation Spaceborne Wind Scatterometer and CubeSat Antennas: Lightweight 3D Printed Inhomogeneous Lens Antennas and Dual Reflectarray Antennas." –presented at the University of Michigan Radiation Laboratory Seminar for the IEEE Remote Sensing Chapter, Ann Arbor, April 2019.