

CAPABILITIES IN
SUPPORT OF THE



ARTEMIS
MISSION
AT

FIU

FLORIDA INTERNATIONAL UNIVERSITY

M-STAR

WE ARE EXCITED THAT FLORIDA INTERNATIONAL UNIVERSITY HAS TAKEN ITS FIRST STEPS

in contributing to the research of space technology by launching the MUREP Space Technology Artemis Research (M-STAR) project with grant funds from NASA. A recent initiative of NASA's Minority University Research and Education Project (MUREP), the M-STAR program aims to provide more opportunities for a diverse student base to conduct innovative research that will contribute to NASA's exploration of the Moon, Mars and beyond, through the NASA's Space Technology Mission Directorate (STMD) funding opportunities. Led by Dr. Daniela Radu and Dr. Cheng-Yu Lai, FIU's proposal was selected for one of 16 awards made to 15 universities. As part of the grant activities at FIU, two workshops have been held — one in December of 2020, and the other in January of 2021 — to discuss the priorities of the program and to examine how to best collaborate and align our ventures. In addition, we were fortunate to have Dr. Jose Nunez, of NASA Kennedy Space Center, participate as a keynote speaker. You'll find his profile within these pages, as well. Thank you for your interest in our project.



Dr. Daniela Radu

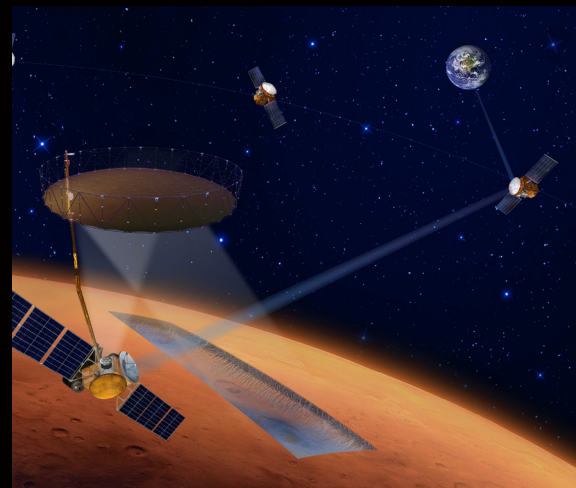


Dr. Cheng-Yu Lai

MUREP SPACE TECHNOLOGY ARTEMIS RESEARCH (M-STAR) PLANNING GRANT

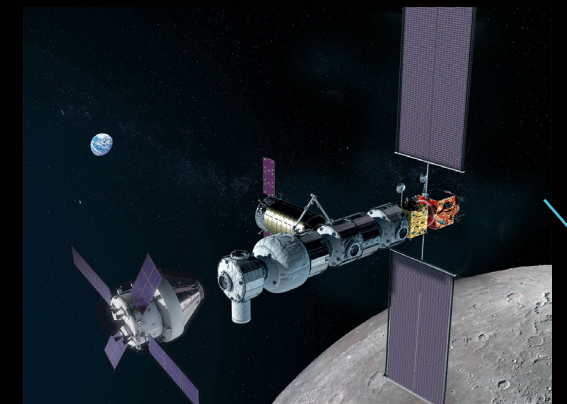


The Minority University Research and Education Project (MUREP) is the flagship NASA platform for providing financial assistance via competitive awards to Minority Serving Institutions (MSIs), including Historically Black Colleges and Universities, Hispanic Serving Institutions, Asian American and Native American Pacific Islander Serving Institutions, Alaska Native and Native Hawaiian Serving Institutions, American Indian Tribal Colleges and Universities, Native American Serving Nontribal Institutions and other MSIs, as required by the MSI-focused Executive Orders.



The investments made by MUREP aim to create a mutual partnership with the MSIs by assisting faculty and students in research and providing authentic STEM engagement related to NASA, while assisting NASA to meet the goal of a diverse workforce through student participation in internships and fellowships at NASA centers and the Jet Propulsion Laboratory (JPL).

All MUREP activities address NASA Strategic Goals and Objectives: "Strategic Goal 3: Address national challenges and catalyze economic growth" and the "Strategic Objective 3.3: Inspire and engage the public in aeronautics, space, and science."



A recent opportunity in the MUREP constellation, MUREP Space Technology Artemis Research (M-STAR) aims, among many other goals, to promote MSIs participation in NASA Space Technology Mission Directorate (STMD) opportunities, focusing on engaging participation of faculty, researchers and students at MSIs in the research programs of NASA's STMD, while promoting mechanisms that ensure the diversity of workers at NASA.



FIU

FLORIDA INTERNATIONAL UNIVERSITY

FIU is a Hispanic Serving Institution (HSI) serving a highly diverse student population. As one of the three Hispanic Serving Institutions in the State University System of Florida, and the largest university in South Florida, FIU serves a student body of more than 55,622 enrolled students (Spring 2021 enrollment). The most recent student FIU demographic data show that more than 37,000 students are Hispanic/Latino and more that 7,000 are African American, totaling 80% of enrolled students from traditionally underrepresented minority groups in STEM. FIU opened in Miami in 1972, and rapidly evolved through tremendous programmatic growth. Today, it offers more than 180-degree programs. Designated as a top tier research institution, FIU emphasizes research as a major component in the university's mission.



FIU'S COLLEGE OF ENGINEERING & COMPUTING is an educational leader in a changing economic, technological and social environment. As the research engine of the university, the college is proud of its growth and accomplishments in recent years. Research expenditures have more than doubled from FY2012 to FY2020 (\$17.4 million to \$34.5 million), and the number of patents awarded to our faculty has increased nearly six fold. Furthermore, our ASEE and NSF HERD rankings have seen significant improvements. **We rank #1 in the continental U.S. in awarding bachelor's degrees to Hispanic students and #6 in awarding bachelor's degrees to African Americans***.

**Source: American Society for Engineering Association (ASEE) 2019 Engineering Statistics*



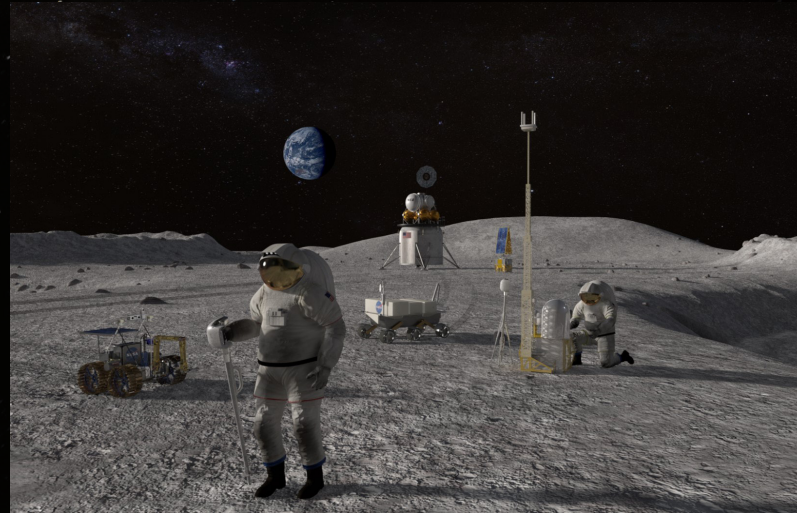
Dr. Jose Nunez

Dr. Nunez became Kennedy Space Center's (KSC) University Partnerships & Small Satellite Capabilities manager in June 2019. In this capacity he is tasked with increasing collaborations between university principal investigators and KSC as well as leveraging infrastructure to increase University Small Sat development activities. Before that he was the chief of the Flight Technologies Branch for the Exploration Research and Technology Programs Office at the Kennedy Space Center, NASA. In this capacity, he led a group of science and technology researchers in the areas of electrostatics, advanced habitats, suborbital flights, unmanned aerial vehicle sensors, and space flight demonstrations.



RESEARCH

Dr. Nunez provided an overview of NASA's plans of going back to the Moon – The Artemis Program, KSC's research and technology areas, opportunities for engaging in research opportunities across the Agency and KSC and a short overview of his 32-year career at NASA, where he has performed in multiple leadership, engineering, project and mission management roles working on the International Space Station (ISS) Program with government, contractor and university personnel across the U.S. and internationals such as Brazil, Canada, Japan, Germany, Italy and Spain.



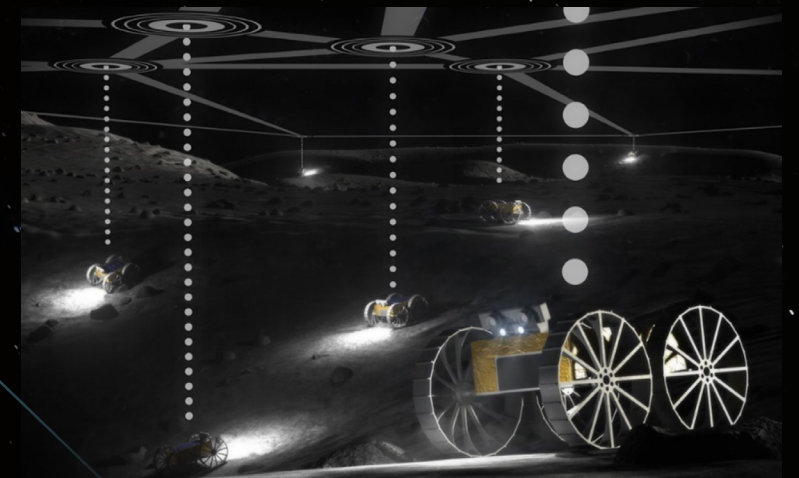
Dr. Daniela Radu

Dr. Daniela Radu is an associate professor in the Department of Mechanical and Materials Engineering at Florida International University (FIU). Her background covers a broad range of disciplines, and she is combining materials science with chemistry and nanotechnology to synthesize novel materials with properties that enable their application in renewable energy. Radu holds a Ph.D. in chemistry from Iowa State University and has further completed a three-year postdoctoral fellowship at The Scripps Research Institute - California. Prior to her academic appointments, she was a senior scientist at DuPont where she developed a novel technology for thin-film PV using Earth-abundant materials.



RESEARCH

Dr. Daniela Radu is an associate professor in the Department of Mechanical and Materials Engineering at Florida International University (FIU). Her background covers a broad range of disciplines, and she is combining materials science with chemistry and nanotechnology to synthesize novel materials with properties that enable their application in renewable energy. Radu holds a Ph.D. in chemistry from Iowa State University and has further completed a three-year postdoctoral fellowship at The Scripps Research Institute - California. Prior to her academic appointments, she was a senior scientist at DuPont where she developed a novel technology for thin-film PV using Earth-abundant materials. Dr. Daniela Radu's research in the Nanomaterials Laboratory is centered on nanostructured materials for optoelectronic applications. Among other materials, the group explores perovskite nanostructures as well as intermediate bandgap transition metal chalcogenides (TMCs) for their application in solar photovoltaics. Tuning materials bandgaps by employing both chemical and physical methods opens avenues for achieving optimal solar absorption. The goal is to use doping and compositional changes that lead to the creation of new materials for inexpensive and scalable multijunction solar cells toward increasing their power conversion efficiency beyond 30%.





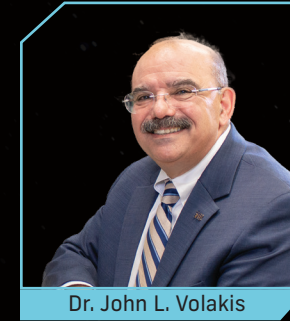
Dr. Cheng-Yu Lai

Dr. Cheng-Yu Lai is an associate professor in the Department of Mechanical and Materials Engineering at Florida International University (FIU). He obtained his Ph.D. from Iowa State University in inorganic chemistry and continued his preparation as a postdoctoral fellow at The Scripps Research Institute - California. After spending a few years as an industrial research scientist with DuPont Central Research and Development, Dr. Lai moved back to academia. He joined Delaware State University in 2012 and in 2018 came to FIU, where his advanced functional materials research group focuses on materials development, including their synthesis and processing.



RESEARCH

Dr. Cheng-Yu Lai's research group focuses on advanced functional materials including nanomaterials in the two-dimensional (2D) realm, with applications spanning from optoelectronics to the biomedical field. Space-related applications include fine jet printing of 2D materials, such as metals and semiconductor inks, for accomplishing lightweight components for electronics and quantum photonics. Synthesis of materials accomplished through both solution-phase and solid-state methods is accompanied by their evaluation through modern characterization techniques, applied to identify compositional purity as well as 2D materials morphology.



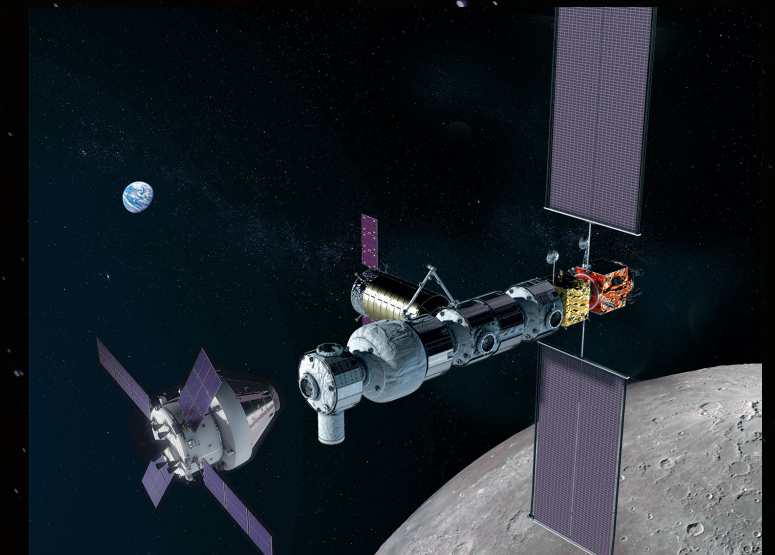
Dr. John L. Volakis

John L. Volakis is a professor of electrical and computer engineering and the Dean of the College of Engineering and Computing at Florida International University (FIU). His previous appointments include 19 years as a professor at The University of Michigan-Ann Arbor, 15 years as the Chope Chair Professor at The Ohio State University and two years at Boeing. He has published over 445 journal papers, 920 conference papers, 8 books, 30 book chapters and over 30 patents/disclosures. His google h-index=73 with over 27,000 citations. He has mentored 100 Ph.D.s/Post-Docs and received 43 best paper awards with them. He is an IEEE, AAAS, NAI, URSI and ACES Fellow.



RESEARCH

Research activities within NASA interests include 1) Wearable electronics using a unique textile weaving process employing highly conductive threads. Antennas, microwave circuits and simple sensor circuits integrated into garments have been demonstrated in recent years to enable hands-free communications for space and personal communications. A new class of remearable wearable packages have also been proposed for integrating wearable components with lumped electronic components. 2) Low-cost, foldable, and deployable, physically large antenna apertures operating from 200MHz to 4GHz and packable in a volume of 0.125U. Using this technology, we proposed CubeSat and nano-satellite constellations to deliver 50-fold imaging resolution. 3) Reduced power and hardware beam formers to significantly increase communication link gain and imaging resolution, by allowing each CubeSat to retain its illumination over the same spot as it orbits; and 4) Ka-band satellite interlink for constellation synchronization, and beam forming and synthetic aperture realization.





Dr. Osama Mohammed

Dr. Osama Mohammed is a Distinguished Professor and Associate Dean of Research at the College of Engineering and Computing, FIU. He is world-renowned for his expertise in power and energy systems. He has interests in design optimization and physics-based modeling in electric drive systems. His interests also include electromagnetic signatures, wide-bandgap devices and switching techniques in power electronic systems. His recent research projects include smart-grid distributed control, interoperability, and energy cyber-physical systems and security. He has numerous highly cited publications in the refereed literature and holds 16 patents. Several others are pending. Professor Mohammed is a Fellow of IEEE, a Fellow of ACES and a recipient of the prestigious IEEE PES Cyril Veinott Electromechanical Energy Conversion Award.

RESEARCH

The development of secure operation and cybersecurity capabilities in energy systems should span over multiple strategies, in the near term, midterm and long term. Continuous security state monitoring across cyber-physical domains is the goal in the near term. The development of continually defending interoperable components that continue operating in degraded conditions is required in the midterm. Developing methodologies to mitigate cyber incidents to return to normal operations quickly is necessary for all system components in the long term.

In distributed energy management systems, the protection must be adaptive. It is assisted by communication networks to react to dynamic changes in the microgrid configurations. In this regard, this presentation will also describe a newly developed protection scheme with extensive communication for power networks to monitor the microgrid during these dynamic changes. Robustness and availability of the communication infrastructure are required for the success of protection measures.



Dr. Arvind Agarwal

Dr. Arvind Agarwal is a Distinguished University Professor and Chair of the Department of Mechanical and Materials Engineering at Florida International University (FIU). Professor Agarwal's current research interests include advanced materials processing, cold and plasma spray, ultrahigh temperature ceramics, nanocomposites and mechanical properties of low dimensional and biological materials. Dr. Agarwal has published more than 350 technical articles, including three books, and seven edited books. He has delivered ~200 presentations at national and international conferences, including 35 keynote/invited lectures. Prof. Agarwal is the inventor of seven U.S. patents and four disclosures.



RESEARCH

Lightweight alloys of Aluminum (Al) and Titanium (Ti) are the significant components of space systems because of their high strength-to-weight ratio. However, their inadequate tribological response in the presence of lunar regolith results in premature failures. This study aims to develop advanced wear and impact-resistant coatings to protect these components and enhance their durability in lunar conditions. BN (Boron Nitride), with its ability to form tribofilm against wear and the capacity to resist radiation-induced brittle fracture, serves as an ideal material for this specific application. Two novel coatings BN-Al and BN-Ti, will be produced by plasma spray technique on conventionally and additively manufactured (CM and AM) substrates. These coatings will be tested against abrasive and erosive wear under various lunar regolith simulants on a custom-made erosion test rig.





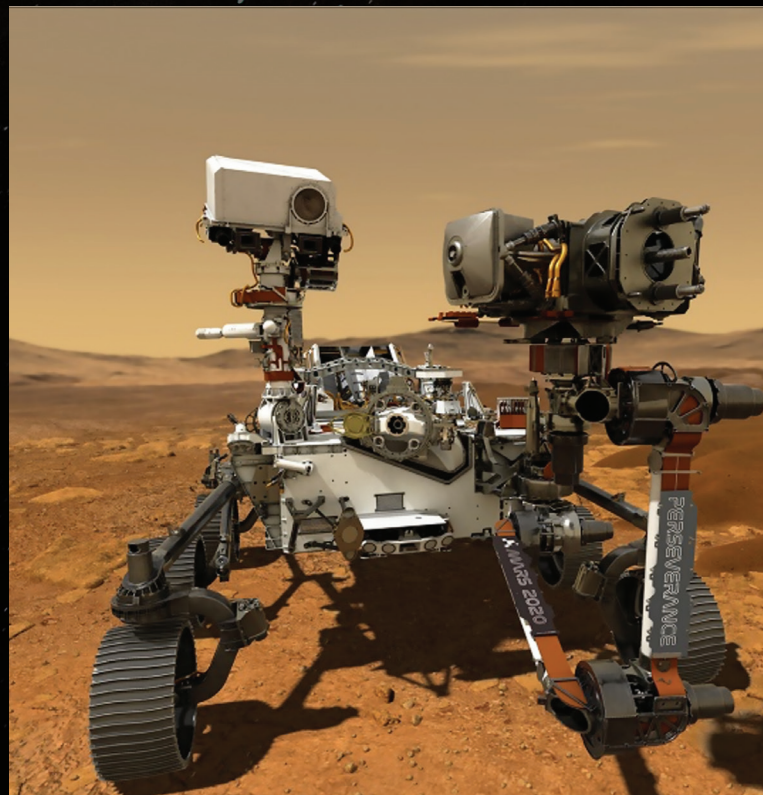
Dr. Dwayne McDaniel

Dr. McDaniel is an associate professor of Mechanical and Materials Engineering at FIU. He has been working in the area of robotic systems and applied research for over 20 years and is currently a member of the ASME Crawler/Ground Robotics for Inspection Committee. He has lead efforts in developing a number of robotic systems for both in-pipe inspections and external pipe systems. He has over 90 publications in journals and proceedings and has lead research efforts for various agencies and industry partners including DOE-NETL, DOE- MSIPP, ONR, ARO, FAA, NOAA, SAIC and Quassat. Dr. McDaniel has a Ph.D. in Engineering Mechanics from the University of Florida and is a registered professional engineer in the State of Florida.



RESEARCH

Dr. McDaniel's research has primarily focused on the development of inspection robotic systems needed for constrained environments. This includes the design, development, testing and deployment of systems that are used in locations that site personnel cannot access or that pose health risks. The systems include internal and external pipe crawlers for the nuclear, power and petroleum industries and integrate sensors for the detection, quantification and repair of various types of infrastructure. In addition, he has managed the development of non-magnetic wall crawlers and autonomous platforms for inspection and surveillance applications. Specific research areas include system design, path planning, non-linear controls and health monitoring.



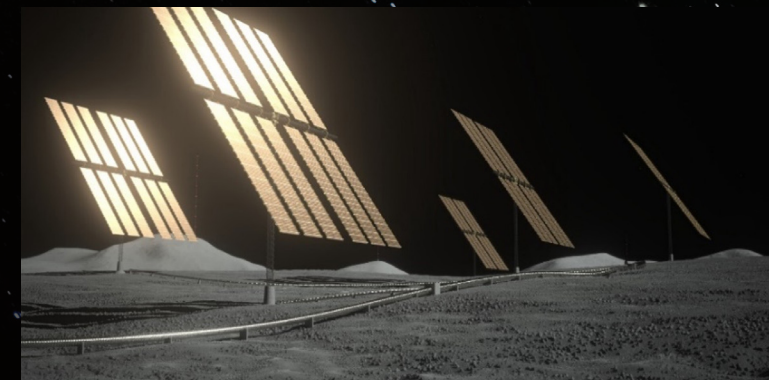
Dr. Raphael G. Raptis

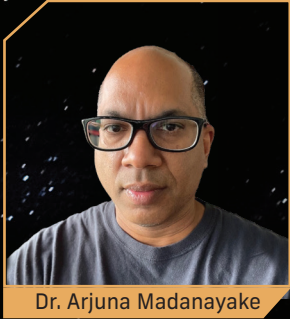
Raphael G. Raptis obtained his B.S. in chemistry from the Aristotle University of Thessaloniki, Greece, an M.S. in chemistry from the University of Texas at El Paso, and a Ph.D. in inorganic chemistry from Texas A&M University. Following postdoctoral work at Texas A&M University and the Research School of Chemistry, Australian National University, Canberra, Australia, he became an assistant professor at the University of Crete, Greece, and the University of Puerto Rico, Rio Piedras, where he rose to associate and full professor. In 2013, he joined the Department of Chemistry and Biochemistry at Florida International University, where he conducts research in inorganic chemistry and supervises the Departmental Single Crystal X-ray Crystallographic Facility.



RESEARCH

Professor Raptis and his research group pursue research in synthesis and structural and spectroscopic characterization of transition metal pyrazolato complexes, with particular emphasis on polynuclear, redox-active species. The electron transfer, spectroscopic and magnetic properties of mixed-valent species are of particular interest. The incorporation of photochemically- and/or redox-active structural building units (SBUs) into the lattices of metal-organic frameworks (MOFs) leading to porous materials with externally controlled gas sorption properties has been a central theme among the pursuits of his laboratory. The goal of these studies is the preparation of gas sorbents cycling without the use of pressure/temperature swings (requiring heavy mechanical pumps) but applying solar energy-powered electrochemical or photochemical means. Porous materials with spin-glass behavior, and the introduction of flexible ligands and trimetallic spin cross-over (SCO) units to MOF design have been recent achievements of the laboratory.





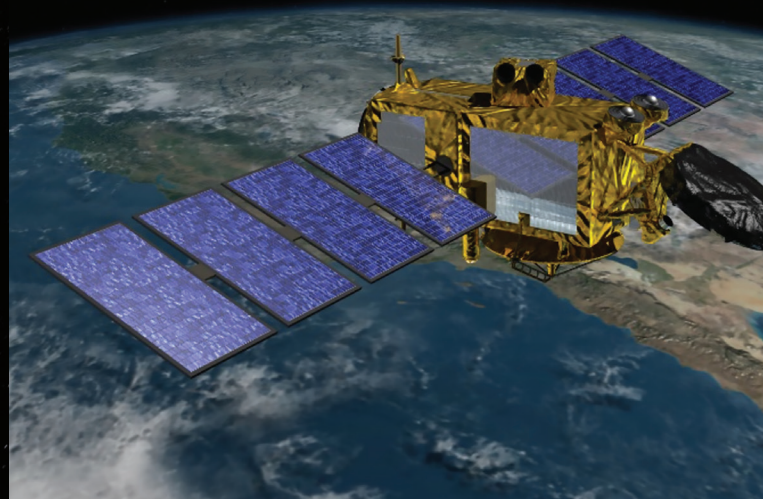
Dr. Arjuna Madanayake

Dr. Arjuna Madanayake is an associate professor of Electrical and Computer Engineering at Florida International University (FIU). He completed his Ph.D. (2008) in electrical engineering and a MSc. (2004) in electrical engineering, both from the University of Calgary, Canada. He has a B.Sc. (2002) in electronic and telecommunication engineering from the University of Moratuwa, Sri Lanka. Dr. Madanayake conducts research in one- and multi-dimensional signal processing, wireless communications, circuits, electronics and digital/microwave systems including CMOS and FPGA based designs.



RESEARCH

Dr. Madanayake is experienced in all-types of RF/microwave and mm-wave wireless and radar system designs, including algorithms, circuits, architectures and system level implementation of antenna array processors. He is exploring applications of advanced array processors for 6G and space applications with particular emphasis on multi-beam and adaptive fully digital beamforming receivers for focal plane array (FPAs) on multi-pixel dish antennas, aperture arrays and sub-THz wireless communications having multi-GHz basebands. Dr. Madanayake is also exploring AI-enabled spectrum management, interference management, massive-MIMO and wideband full-duplex arrays for space applications of the future.



FIU'S COLLEGE OF ENGINEERING AND COMPUTING

POINTS OF PRIDE

44
patents
(Calendar Year 2020)

\$289K
per faculty
research expenditures
(FY2020-21)

20%
female in
undergraduate programs

#1
in awarding
engineering degrees
to Hispanics

\$49.3M
in research awards
(FY2020-21)

50
research labs,
centers

28%
female in
graduate programs

#8
in awarding
engineering degrees
to African Americans

\$40.2M
in research expenditures
(FY2020-21)

7,746
total students
(6611 undergrad +
1135 graduate) Fall 2021

Nearly
2,000
degrees awarded
in AY2020-21

Researchers at the COLLEGE OF ENGINEERING AND COMPUTING collaborated with colleagues at the COLLEGE OF ARTS, SCIENCE, AND EDUCATION to produce highly innovative technological advancements in support of Artemis and other NASA missions, while developing a talent base in STEM disciplines.

Faculty equity and diversity is an essential element of FIU's academic excellence.

FIU'S DIVERSITY MENTOR PROFESSOR PROGRAM

is a special initiative to recruit excellent STEM faculty to FIU who have a history of and commitment to the mentorship of women and underrepresented minority students in STEM, particularly Hispanic-American and African-American students.

FIU

COLLEGE OF ENGINEERING & COMPUTING
COLLEGE OF ARTS, SCIENCE, AND EDUCATION