Laboratory for Applied Remote Sensing, Imaging and Photonics

LARSIP is a multidisciplinary laboratory dedicated to the research and implementation of Remote Sensing, Hyperspectral Image Processing, Optical Imaging, Signal and Image Processing, Geographical Information Systems (GIS), Emergency Response Systems, Global Positioning Systems (GPS) technologies, Applied Electromagnetics and Bio-Optics applications. LARSIP is a facility located within the Department of Electrical and Computer Engineering at UPRM.

The objectives of LARSIP are to develop advanced data analytics and machine learning algorithms and technologies for information extraction and management (particularly from remote sensing sensors), and to educate and train students in the different technologies associated with remote sensing and signal processing. LARSIP provides a focus for multi-disciplinary research and education by promoting research and education projects that involve electrical and computer engineering researchers and students interacting with researchers and students in application areas such as marine sciences, geology, civil engineering, and chemistry, among others. LARSIP has extensive computing and image processing equipment as well as advanced hyperspectral optical imaging equipment (ranging from the visible and infrared spectrum) as well as portable spectrometers and underwater enclosures for fieldwork and collection of diverse imaging data.

The National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and the American Telephone and Telegraph Corporation (AT&T) provided initial funding for LARSIP and its research projects. Currently, LARSIP receives funding from NSF, NOAA, Lockheed Martin Corporation and the DoD. LARSIP function as a training center in a bilingual (Spanish and English) environment for current and future scientists and engineers of the Caribbean region and the South and Central Americas. The training centers are multidisciplinary in scope, serving Mayaguez and other UPR campuses. Universities and institutions in other countries are encouraged to form and establish liaisons with LARSIP through Memoranda of Understanding or other similar arrangements.

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NOAA Collaborative Science Center for Earth Systems Sciences and Remote Sensing Technologies (NOAA – CESSRST)

NOAA-CESSRST conducts research, educates, and trains a diverse group of students, early career scientists, and engineers, in NOAA-related science missions. The goal is to help create a diverse STEM workforce for NOAA and its contractors, Academia, Industries and the Private Sector. Established in 2016 through a national competition, and funded by the National Oceanic and Atmospheric Administration, CESSRST is led by The City University of New York (CUNY) and brings together Hampton University, University of Puerto Rico at Mayaguez; San Diego State University, University of Maryland Baltimore County, and University of Texas at El Paso. CESSRST also incorporates several industrial partners like STC, AER, Nobilis, SSAI, ERT, and IMSG. The consortium brings together world class research capabilities for remote sensing technology consisting of exemplary faculty and research staff, advanced computational facilities, instrumentation for direct readout of satellite data and calibration/validation, experience in state-of-the-art remote sensing technology development for satellite and surface-based remote sensing, and in situ sensor systems. These capabilities drive an ambitious and research agenda for new applications of remote sensing and advancing the understanding of Earth System processes and improving predictions of weather and climate.

Faculty, scientists, and students from the Departments of Electrical and Computer Engineering, Computer Science and Engineering, Civil Engineering and Surveying, and Marine Sciences comprise the UPRM CESSRST team. The focus of the UPRM team research work is in remote sensing of land and coastal ecosystems, using satellite and UAV-mounted sensor data.

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Space Information Laboratory (SIL)

SIL was founded as part of the NASA Tropical Center for Earth and Science Studies (TCEESS) with the purpose of receiving and distributing satellite data from different sources. The facility is currently

housing a NOAA Direct Broadcast Satellite Receiving Station, with capability of receiving data from the Suomi-NPP, JPSS-1, Aqua, Terra, NOAA-18, NOAA-19, METOP-A, METOP-B, and GCOM-W1 satellites, among others. Data is primarily used by the Space Science and Engineering Center from the University of Wisconsin, Madison, for ingestion into their forecast models, and for developing diverse imagery. Data is also used by UPRM NOAA CESSRST researchers for remote sensing of coastal environments and for calibration and validation of localized optical and microwave sensors, and other researchers at UPRM. This data is available for academic and academic research purposes. In addition, SIL houses a University of Colorado project for Multi-Constellation Multi-Frequency GNSS Data Collection Arrays for Low Latitude Atmospheric Effects Studies.

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Weather Radar Network: Collaborative Adaptive Sensing of the Atmosphere

A weather research network comprised of two types of X-band weather radars was developed thanks to funding from two NSF programs; Engineering Research Centers (ERC) and Major Research Instrumentation (MRI). The first type of radars are the small Off-the-grid (OTG) radars which measure only rainfall rate and are capable of operating with renewable (wind and/or solar) power in case of blackouts which are common during extreme weather events. The other type of radars are more sophisticated Doppler Polarimetric weather radars called Tropinet, which are capable of measuring rainfall, wind speed and other hydrometeors such as hail, among others. This project provided the first polarimetric weather radars on the island. The network comprises 3 Tropinet and 5 OTG distributed mainly on the west side of the island of Puerto Rico and they complement the data from the NWS radar located on the East of the island (in Cayey).

The new network seeks to advance fundamental knowledge and provide societal benefits by creating a new engineering paradigm for observing, detecting, and predicting weather and other atmospheric phenomena. It uses of a dense network of radars capable of very high spatial and temporal resolution, which is necessary for better prediction of landslides, flooding, tornado warnings and other meteorological phenomena. These systems operate collaboratively within a dynamic information technology infrastructure, adapting to changing conditions in a manner that meets competing needs of end users, the government, private industry, and the public. This multi-million center brings together a multidisciplinary group of engineers, computer scientists, meteorologists, sociologists, graduate and undergraduate students, and industry and government representatives to conduct fundamental research, develop enabling technology, and deploy prototype engineering systems based on a new paradigm: Distributed Collaborative Adaptive Sensing (DCAS).

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Rapid System Prototyping Laboratory (RASP)

The Rapid System Prototyping Laboratory (TI-ICDL) is located in Room 208, Stefani Building in the UPRM campus. The facility provides 420sq. ft. of space devoted to the tasks of developing technologies and applications for prototyping algorithms, circuits and electronic systems on quick turn-around technologies like Field Programmable Gate Arrays (FPGA) and advanced hardware platforms. RASP was established in 2002 with the sponsorship of multiple entities, including Texas Instruments, The National Science Foundation, IBM, Xilinx, Harris, and Lockheed-Martin, among others. The main mission of the RASP Laboratory is to enable graduate students acquire the necessary training, skills, expertise, and capabilities to conduct academic and industrial research work in the field of rapid prototyping digital and mixed-signal electronic systems..

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The Power Electronics Laboratory

The main focus of this laboratory is for advance undergraduate education on power electronics and aerospace systems using graduate research techniques. Graduate students are welcome to do partially their related research work in the facility, and serve as mentors to the undergraduate research students. This facility is located in Stefani building (S101) and occupies about 100 sq ft. This laboratory

has one Printed Circuit Board Rapid Prototyping System, 3D Printers, High temperature PCB Oven, Portable Drill-Saw Machinery, Network, Impedance, Spectrum Analyzer 10Hz-500 MHz, Milling-Drilling Machinery, and Lead-Free Soldering Station. This facility also includes the usual assortment of oscilloscopes, waveform generators, multi-meters, computers, etc. The laboratory has Software Licenses for SABER, P-spice, Matlab, and others useful for the design unmanned systems. This facility is useful for fabrication, characterization, and testing unmanned system prototypes and renewable energy systems. The UPRM's Power Electronics Laboratory is sponsored in part by the UPRM's ECE Industry Affiliates Program, Sandia National Laboratory, CIESESE Program and the US DoEnergy/NNSA.

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Texas Instruments Integrated Circuits Design Laboratory (TI-ICDL)

The Texas Instruments Integrated Circuits Design Laboratory (TI-ICDL) is located in Room 210B, Stefani Building in the UPRM campus. The facility provides 800 sq. ft. of space devoted to the tasks of designing and testing analog, digital, and mixed-signal integrated circuits and systems. The facility was established in 1999 with the sponsorship of Texas Instruments (TI) under the UPRM-TI Collaborative Program. It provides 16 design workstations running industry-grade software tools for the design entry and verification of integrated circuits developed in bipolar and MOS technologies. In addition, the lab provides four testing stations with state-of-the- art test and measurement tools used by senior and graduate students, in advanced and graduate course projects in electronics as well as graduate research students for their projects.

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Microgrid Laboratory

The Microgrid Laboratory offers several experimental research, development, and education platforms, integrated in a single operational system. The facility is designed to run experiments at all levels of controls. It is composed of a DSPACE system and an inverter-based setup, two electronic DC power sources, loads, and two computers. The setup consists of four inverter-based generators, which can simulate different microgrid configurations. The microgrid setup includes the following equipment: 1×dSPACE system, which includes: 1 CPU board (ACE1006), an expansion box (PX10), a 16-channel A/D board (DS2004) and a connection (CP2004), 2 digital I/O boxes (DS4003), output board (DS5101) and connector (CP5101), the box of the whole system, and the digital bus cable, 1×10kVA transformer for grid connection; 4×2.2kW DANFOSS inverters; 1×Data logger; 2×screens; and 1× PC. In addition, to generate the DC link that supply each DC/AC inverter the facility has a 5kW AC/DC power electronics supply.

Also, an electric motors and drives setup is dedicated to component testing and prototyping, component modeling, and simulation. There is a test bench for implementation of control and identification algorithms for drives and power electronics applications. The test bench is based on the rapid prototyping system for control algorithms using the Dspace 1104 board. The laboratory also has the following equipment: UPRM built 3 phase rectifier/inverter for motor control, 1 HP; Controllable DC power supplies.

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Microwave and Millimeter-wave Antennas and Remote Sensing Systems Laboratory (MAReS)

MAReS was created in 2000 through a Major Research Instrumentation grant from NSF. The laboratory instrumentation includes microwave and millimeter-wave instrumentation that allows us to perform circuits and antenna measurements up to 67 GHz, rapid prototyping equipment for printed circuit boards up to 10 GHz, and design workstations with commercial software for microwave circuits and electromagnetic simulations. The laboratory facilities have supported numerous research projects throughout the years, including projects under the NSF Engineering Research Center for Subsurface Sensing and Imaging Systems (CenSSIS), NSF Engineering Research Center for Collaborative Adaptive Sensing of the Atmosphere (CASA), and the NASA Tropical Center for Earth and Space Studies (TCESS). The laboratory has also supported projects from the Army

Research Office, the Air Force Research Laboratory, the Department of Energy, and the Puerto Rico Science, Technology and Research Trust, in addition to NSF and NASA. The laboratory currently supports the NOAA Cooperative Science Center for Earth System Sciences and Remote Sensing Technologies (NOAA CESSRST), and the NSF project "*CRISP Type 2: Interdependent Electric and Cloud Services for Sustainable, Reliable, and Open Smart Grids*," as well as other unfunded graduate and undergraduate projects. The laboratory has been a central component in obtaining more than $7.35M in research funding since its creation in 2000, with an initial investment of $677,000 by NSF.

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