Capabilities Statement
Gregory H. Huff

Program Information

Securing Compartmented Information with Smart Radio Systems (SCISRS) Research Program
IARPA

Point of Contact

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Overview

Prof. Gregory H. Huff is with the Electromagnetics Group in the Department of Electrical Engineering at The Pennsylvania State University in State College, PA. His research group specializes in reconfigurable antennas systems and other innovative solutions to the electromagnetic challenges arising from the deployment of distributed and disparate networks of wirelessly connected intelligent cyber-physical systems and their application spaces in science, industry, and defense. This includes the development of algorithms and experimental techniques to study chaotic swarms of autonomous vehicles, dense IoT sensor networks, and smart infrastructure, where the overarching role of electromagnetic systems on these platforms are to serve as information transducers that perform complex sensor fusion and aggregation tasks in physically hostile or extreme environments.

Huff's work integrates advances in software defined radios, machine learning techniques, and distributed control algorithms with adaptive hybrid beamforming and adaptive antenna techniques to study new operational paradigms and application spaces for these systems. He also examines critical technology gaps that arise when considering the physical interaction within the electromagnetic spectrum they reside in, and the impact of these gaps as they extend from complex cybersecurity vulnerabilities to maintaining basic wireless connectivity for emergency command and control. This includes recent advances in materials science and applied electromagnetics to improve physical resiliency and integrate context awareness into these wireless systems through enhanced access to the electromagnetic environment. For this research program, Huff seeks to team with experts in machine learning and signal processing where he can contribute his expertise synergistically to consider the role of adaptive antenna systems for capture, detection, and localization of EM sources.

Bio: Prof. Gregory H. Huff received his B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Illinois at Urbana-Champaign, in 2000, 2003, and 2006, respectively. He joined the faculty in the Department of Electrical Engineering at Pennsylvania State University in 2018 after serving on the faculty at Texas A&M University from 2006 to 2018. Prof. Huff apprenticed professionally and attained the rank of Chef de Cuisine with specializations in French and Mediterranean fare Prior to his academic career. As a faculty member, his awards and honors

include the Presidential Early Career Award for Scientists and Engineers (PECASE) awarded through the Department of Defense and the NSF CAREER award. His current research in electromagnetic functionalization of intelligent cyber-physical systems blends concepts from material science engineering, aerospace engineering, and other focus areas to enable electromagnetic agility in swarms and other distributed systems.

Experimental and Other Facilities

1. Antenna and Radio Communications Laboratory

This design studio and prototyping laboratory includes state-of-the-art system engineering and applied electromagnetics tools for the design, test, and measurement of complex systems and networks. It is a collection of laboratory spaces located in the Electrical Engineering (EE) East Building that combined have over 1500 sq. ft. dedicated to the conception, design, and testing of advanced electromagnetic devices, mobile systems, wireless networks, and a range of other capabilities. This includes a wide range of fabrication, assembly, and automated measurement capabilities for adaptive and multifunctional RF, microwave, and millimeter antennas, circuits, and systems. The equipment housed in this facility includes the following:

- Vector Network and Signal Analyzers
- Thermal Imaging Systems
- Automated Circuit Etching and Fabrication
- Advanced Additive Manufacturing and Post Processing
- Electromagnetic and Multi-Physics Field Solvers and Simulation Tools
- Software Defined Radio Phased Array Test-Bed

2. Anechoic Chamber and Automated Antenna Measurement Systems

The Department of Electrical Engineering at Pennsylvania State University is home to a state-of-the-art automated three-axis dual-polarized antenna measurement system. It includes a newly renovated anechoic chamber with testing capabilities up to 70 GHz. This features a 1m quiet zone using an automated measurement system for RF, microwave, and millimeter-wave frequencies. This structure is instrumental to prototyping and testing. This measurement system provides post-processing calculations that include derivation of antenna half-power beam-width, directivity, gain, radiation efficiency, total radiated power, and a myriad of additional performance metrics and advanced analysis tools. Other capabilities include a free-space time-gated compact range system and outdoor antenna test range with towers up to 100 m.

3. Raj and Jeannette Mittra Microwave Lab

This laboratory space is dedicated to the support of teaching activities including courses on UHF and Microwave Engineering, Engineering Electromagnetics, Antenna Engineering, Satellite Communication, Software Defined Radios, and future RF/mm-wave Design Engineering courses.

4. Institute for Computational and Data Sciences-Advanced Cyber Infrastructure

Penn State's Institute for Computational and Data Sciences (ICDS) operates the Advanced CyberInfrastructure (ICDS-ACI), the university's state-of-the-art high-performance research cloud.

Data Center Facilities

ICDS-ACI equipment is located a newly-constructed Data Center facility at Penn State's University Park Campus. This facility operates in compliance with all Penn State IT policies.

Data Center Resources: The ICDS-ACI high-performance research cloud is composed of hardware that is interconnected over high-speed network fabrics, and includes various software offerings and services.

Hardware: ICDS-ACI maintains 26,000 computational cores. ICDS-ACI offers four different core configurations: high-memory cores (1TB RAM per server), standard-memory cores (256 GB RAM per server), and basic-memory cores (128 GB RAM per server), and GPU cores (using NVidia Tesla K80 GPU accelerators).

Storage: ICDS-ACI maintains 20 PB of data storage capacity. The storage is comprised of 8 PB of active storage pools that provide immediate data access and retrieval, and 12 PB of near-line storage for long-term and archival purposes.

Software: ICDS-ACI maintains and regularly updates an expansive software stack. The stack currently contains 240 applications, with more added at regularly-scheduled intervals. The applications include security monitoring software (e.g., OSSEC), batch schedulers (e.g., MOAB, Torque), compilers, file transfer programs, and communication libraries (e.g., MPI, OpenMP). The stack also contains software applications commonly used by researchers, such as MATLAB, COMSOL, R, and Python, as well as programs for performing specialized tasks, such as Abaqus, Quantumwise, TopHat, and Ansys HFSS.

ICDS-ACI Support: ICDS-ACI is maintained by the ICDS staff, who provide network monitoring, backup services, software updates, code optimization, and service-desk support. ICDS uses Solarwinds network monitoring software to monitor the health and status of the network, hardware, and storage.

ICDS Domain-Specific Consultation: ICDS offers domain-specific consulting to assist researchers with optimizing code, leveraging various software applications and in general increasing the efficiency of their research operations. Consultants cover disciplines including Engineering, Chemistry and Materials Science, Data Visualization, Parallelization, and Science Gateways for Big Data Research.