

# Presentation Abstracts

10:45 AM

**Presentation Title:** Use and Abuse - Analyzing Political Emails

**Sponsored by:** RTX (RTX Fellowship Program)

**Faculty Mentor(s):** Dr. Alan Michaels, Jared Byers

**Student Researcher(s):** Daniel H, Alexis H, Aditya K

**Abstract:** Using active open-source intelligence (OSINT) techniques, we are able to test the question of how our personal information is used, shared, or otherwise abused. To do this, created an automated collection framework with realistic fake identities used in one-time online transactions and then passively collect email, voicemail, and SMS responses from that event. The results we will be discussing are from 2000 fake identities signed up to the declared political candidates for the 2024 U.S. elections (U.S. House, Senate pre-primary candidates, and presidential candidates added as announced), tracing how information was used or shared. Additional trends are demonstrated for coordinated intra-party responses to events, the post-election and post-inauguration phases, the lack of direct mailings, and other anecdotes like seeing where the emails are sent out from. This project is all about the data/trends for our personal privacy when providing our information to political candidates.

11:00 AM

**Presentation Title:** Communication Relay System

**Sponsored by:** CACI International Inc.

**Faculty Mentor(s):** Dr. Brad Davis

**Student Researcher(s):** Ivin B, Kidus M, Noah D, Samuel A, Sean M, Brooke S, Jiyoan P, Logan C, Neha B, Albert E, Spencer L, Tiffany W, Christian C

**Abstract:** Beginning with a concept of operations this program developed system requirements and constructed two radio frequency relay systems to demonstrate the requirements for signal transmission over-the-air (OTA) in order to enhance reception at shadowed receive locations. A system team produced a requirements document and specification and tracked and contributed to overall relay construction. A communication team implemented the transmission/receive modules using software-defined radios, implementing a binary phase shift keying modulation. A third group investigated and constructed a portable relay whose RF signal chain includes directional antennas, amplifiers, directional couplers, and filters in a shielded enclosure. Additionally, printed circuit boards have been designed and partially constructed for use in future phases (signal chain, health monitoring system and a power supply). Power is drawn from a 9-volt battery and a suitable voltage regulating circuit. On-board the relay, a health monitoring system samples signal power and tracks the power system health. This information is reported OTA back to a web-hosted control system using a Wi-Fi. The control system instantiates a graphical user interface (GUI), accessible by user devices. The GUI can be user configured and will display relay statistics and the messages passed. Future uses include beamforming and MIMO.

11:15 AM

**Presentation Title:** SPA Hypersonics Alternate Navigation

**Sponsored by:** Systems Planning and Analysis (SPA)

**Faculty Mentor(s):** Dr. Austin Phoenix, Brett Lovell

**Student Researcher(s):** William T, Kasey B, Sean W, Danny C, Joanna H, Jack J, Nicholas D, Nathan H

**Abstract:** Hypersonic vehicles operate in extreme environments where GPS is unreliable due to signal attenuation, jamming, and plasma-induced blackout. This presentation explores several different navigation methods as a GPS-independent alternative. We examine the evolution of alternative navigation from traditional sextants to modern optical tracking systems and assess its feasibility for hypersonic applications. Key challenges include high-speed motion, atmospheric distortion, and platform stability, which impact real-time tracking. Comparisons with terrain-relative navigation, quantum inertial sensors, and signals-of-opportunity highlight potential complementary solutions. This presentation reviews the Technology Readiness Level (TRL) of alternative navigation techniques and identifies advancements needed for autonomous, precise navigation in next-generation hypersonic vehicles.

11:30 AM

**Presentation Title:** CLOUD-based Distributed Radio Frequency Spectrum Sensing and its Application to RF Fingerprinting

**Sponsored by:** Amazon Web Services (AWS), Commonwealth Cyber Initiative (CCI)

**Faculty Mentor(s):** Dr. Alyse Jones, Dr. Maymoonah Toubeh, Dr. Chris Headley, Dr. Stephen Adams

**Student Researcher(s):** Srihan B, Abigail D, Rami G, Akshay P, River T, Dylan G

**Abstract:** In wireless communications, collaborative spectrum sensing is a process that leverages radio frequency (RF) data from multiple RF sensors to make more informed decisions and lower the overall risk of failure in distributed settings. However, most research in collaborative sensing focuses on homogeneous systems using identical sensors, which would not be the case in a real-world wireless setting. Instead, due to differences in physical location, each RF sensor would see different versions of signals propagating in the environment, establishing the need for heterogeneous collaborative spectrum sensing. Hence, this project explores the implementation of collaborative spectrum sensing across heterogeneous sensors, with sensor fusion occurring in the cloud for optimal decision making. Last year, we investigated machine learning-based fusion methods and tested the fused model's ability to perform modulation classification, with a primary goal of optimizing for network bandwidth in regard to next-generation network applications. Our analysis demonstrated that our fusion process was able to optimize the number of features extracted from the heterogeneous sensors according to their varying performance limitations, simulating adverse conditions in a real-world wireless setting. This year, we implemented our framework in hardware for over-the-air testing and for further validation that it can operate in a real-world environment.

11:45 AM

**Presentation Title:** Is NATO More Than Article V?: Furthering Understanding of Civilian Opportunities

**Sponsored by:** Department of State

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Jess G, Thomas Q, Cameron U, Melanie G, Will H, Caroline H, Miabella W, Natalie S, Logan K, Sean K, Eric L, Haleigh H, Marlaina G, Matthew Q, Matthew S, Dori V, Alex A, Elena R

**Abstract:** Commissioned by the U.S. Department of State, specifically the Public Diplomacy section of the Embassy in Helsinki, this project seeks to identify strengths and potential avenues for partnership and leadership within the context of Finland's recent accession to NATO. Given that accession was predicated primarily upon countering Russian security threat, the Embassy expressed interest in determining opportunities to involve Finnish citizens in civilian-led NATO initiatives, including opportunities for employment, education, internships, service, and international engagement. The Embassy also requested that students determine opportunities to maximize Finnish military strategy and deterrence through a NATO-collaborative frame, while emphasizing a desire to assess and consider the opinions of Finnish citizens on the implementation of the above and further NATO-led initiatives.

# Presentation Abstracts

12:00 PM

**Presentation Title:** GenAI and Digital Transformation  
**Sponsored by:** Sponsored by: Naval Surface Warfare Center - Dahlgren Division, SEC, Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E)  
**Faculty Mentor(s):** Dr. Paul Wach, Mary Nerayo  
**Student Researcher(s):** Brady J, Cat P, Adithya I, Bhargava A, Bhavya S, Cameron C  
**Abstract:** The GenAI Overview project aims to help digital engineering adoption through LLMs and SysMLv2. It enables automated text-to-SysMLv2 conversion, translating between text, images, and models, and upgrading older models. These efforts make digital engineering more efficient and effective. The Systems Theory Product develops an LLM powered tool to assist engineers in solving complex systems engineering problems. By integrating machine learning, Gemini APIs, and a Python UI, this software automates key tasks such as verifying system requirements and assessing verification and validation models. The RAG Effectiveness project evaluates distinct database types for retrieval-augmented generation (RAG), a method that improves AI driven knowledge retrieval. It also compares small language models to evaluate retrieval accuracy and generation quality. The goal is to optimize knowledge availability.

12:15 PM

**Presentation Title:** Night's Watch: A Virtual C-UAS Testbed  
**Sponsored by:** Virginia Tech National Security Institute  
**Faculty Mentor(s):** Dr. John Gilbert, Dr. Austin Phoenix, Collin Phillips  
**Student Researcher(s):** Aayan A, Ryan A, Alexander B, Ethan D, Kaiden D, Vincent F, Gautam I, Utsav M, Matthew M, Ronit M, Sunjeet N, Sanjay S, Nico T, Garrett W  
**Abstract:** The Counter-UAS Testing and Research Center (CTRC) is a joint effort between VTNSI and the Mid-Atlantic Aviation Partnership (MAAP), funded by the U.S. Army to advance academic capabilities in countering evolving unmanned aerial threats. This poster presents the development of a modular, virtual environment designed to simulate complex UAS and C-UAS engagements beyond the limits of physical testing. The framework supports many-vs-many scenarios, sensor and countermeasure modeling, and reinforcement learning integration, with connectivity to real-world indoor and outdoor test ranges. Our goal is to accelerate the development and validation of adaptive, intelligent C-UAS systems for national security applications.

12:45 PM

**Presentation Title:** Operation Safe Passage, Digital Engineering for T&E  
**Sponsored by:** Director, Operational Test & Evaluation (DOT&E)  
**Faculty Mentor(s):** Dr. Paul Wach  
**Student Researcher(s):** Emanuel O, Austin L, Trevor I, Walter L, Winston M, Allegra O, Robert S, Liam S, Brandt S  
**Abstract:** Operation Safe Passage advances T&E methods by leveraging Digital Engineering (DE) to develop unmanned systems that ensure safe travel through contested, mined areas.

1:00 PM

**Presentation Title:** ContentCube - The \$5,000 Satellite  
**Sponsored by:** Voyager, Astranis  
**Faculty Mentor(s):** Dr. Kevin Schroeder, Dr. Samantha Kenyon  
**Student Researcher(s):** Julia E, Michael E, Nate H, Gracie P, Larsen V  
**Abstract:** inspireFly is a Virginia Tech undergraduate CubeSat design team. After being injected into low earth orbit by the Nanoracks ISS CubeSat launcher, inspireFly's 1U CubeSat "ContentCube" will extend a boom arm, activate a display screen, and activate a camera system. After deployment, ContentCube will take "selfies" of itself with the display screen on and earth in the background. The objectives of this mission are to test an OLED display screen in space, to provide an early proof of concept for orbital advertising missions, and to inspire future generations of engineers through photos of themselves in space. Constrained to just a 10x10x10cm cube, ContentCube must fit antennas, batteries, a power board, a telemetry board, a payload board, a display screen, a boom arm, and a camera. ContentCube was handed off to its NASA/Voyager Space launch facilitators in mid-March 2025. A multidisciplinary team of students collaborated to collect technical requirements for the commercialization of the Autonomous Systems at Scale SBIR project, with the ultimate goal of government acquisition in the future. The Autonomous Systems at Scale project is intended to develop a prototype for operating multi-agent systems from a single operator.

1:15 PM

**Presentation Title:** Commercialization Strategy for Mobile Distributed Multi-Input/Multi-Output 5G/6G Technology  
**Sponsored by:** Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E)  
**Faculty Mentor(s):** Dr. Daniel Jakubisin, Geoff Kerr  
**Student Researcher(s):** Ahad K, Marlaina G, Sean K, Andrew K, Cynthia N, Joshua O, Krishna V  
**Abstract:** This undergraduate research team aims to support the development and commercialization of advanced 5G/6G communications technology, specifically mobile distributed Multi-In/Multi-Out (dMIMO) systems. The purpose of the project is to create a strategy encompassing marketing, production, training, and policy to ensure widespread adoption and operational success of mobile dMIMO technology in both military and commercial applications. The team is specifically focusing on broadening the appeal of this technology by showcasing use cases beyond military applications in order to promote commercial funding of future research.

1:30 PM

**Presentation Title:** Leveraging OSINT to Map PRC University Partnerships Globally  
**Sponsored by:** Department of State  
**Faculty Mentor(s):** Robert Hodges  
**Student Researcher(s):** Sri G, Arya N, Justin V, John Nally S, Amanda G, Asher M, Ashley W, Avery T, Breanna W, Caleb F, Dante P, Emery M, Emil M, Emily C, Ethan D, Grace J, Harper C, Kyle H, Laura L, Lily B, Lily T, Luke P, Michael W, Noah K, Rabihah W, Rachel W, Sydney D, Taylor B, Will E, Supervisors: Cameron P, Liz M  
**Abstract:** The PRC leverages MOUs between Chinese and foreign universities and research partnerships as means to gain access to potentially dual-use research, data, technology, and equipment -particularly research, data, technology, and equipment relating to emerging technologies. Due to the public facing nature of these research partnerships, open-source data can be leveraged to map the PRC's network of MOUs and research partnerships. This project leverages this open-source information to identify and document partnerships, joint laboratories, and MOUs between universities in the People's Republic of China (PRC) and other universities globally.

# Presentation Abstracts

1:45 PM

**Presentation Title:** Phased Array & Visualization

**Sponsored by:** Naval Surface Warfare Center Dahlgren Division

**Faculty Mentor(s):** Dr. Brad Davis

**Student Researcher(s):** Nick B, Abraham T, Sam S, Ian B, Vanessa B, Joseph N, Alexander J, Kyle W, Zachary V, Reve M

**Abstract:** Beginning with a 16 element, 4x4 array from last year, the team has expanded this project by incorporating an RF signal chain feeding each element. Including the radiating elements, this RF front-end is typically referred to as a [Passive] Phased Array. The RF components behind each elements instantiates a Transmit/Receive (T/R) module. The team has constructed a semi-active T/R module where each element T/R includes RF amplification in transmit and receive channels; however, the source is not integrated with each element's RF components. In our first iteration, we have constructed the T/R modules using connectorized components for a 1x4 linear array. Here, the T/R module is divided into transmit and receive signal paths joined at the radiator by a custom-designed circulator PCB. Each channel (Tx and Rx) also includes phase shifters, limiters and bandpass filtering; the phase shifters also are custom-mounted on a PCB. The fully integrated 16-element phased array has been partially constructed using a modular combination of the T/R modules. All 16 antenna elements and T/R modules are integrated into a custom designed and configured backplane with integrated power and control signaling. Intended future applications include FMCW and pulsed radar, communications and electronic warfare.

2:00 PM

**Presentation Title:** Integration of High-Altitude Balloon Dynamics into AFSIM

**Sponsored by:** The Aerospace Corporation

**Faculty Mentor(s):** Dr. Kevin Schroeder

**Student Researcher(s):** Ashtyn F, Brian V, Ginny S

**Abstract:** High-altitude balloons (HABs) are relatively simple and cost-effective tools for near-space research and atmospheric science. This project aims to model and simulate the dynamics of latex, zero-pressure, and super-pressure balloons within the Advanced Framework for Simulation, Integration, and Modeling (AFSIM) software. Modeling HAB dynamics in AFSIM will expand its capabilities, allowing for improved analysis and simulation of HAB missions. This project explores the governing equations for HAB motion and how they can be implemented in AFSIM. Simple models like the SondeHub predictor are adapted and implemented along with more complex dynamic and thermal modeling. The integration of these HAB dynamics into AFSIM allows for various example scenarios to be developed, including balloon flight prediction and ground station location prediction. Incorporating multiple models for a wide variety of balloon types enhances simulation capabilities, with latex balloons being relevant for short-duration, light-payload weight missions, and zero-pressure and super-pressure balloons being relevant for long-duration, heavy-payload weight missions. Incorporating these models into AFSIM advances its mission planning capabilities and applications.

2:15 PM

**Presentation Title:** Converting SysMLv1 to SysMLv2 using GenAI

**Sponsored by:** Naval Engineering Education Consortium (NEEC)

**Faculty Mentor(s):** Dr. Paul Wach, Mary Nerayo

**Student Researcher(s):** Gordon M, Kelechi E, Junior B, Rohan A, Grant R, Alex Brown, Nate W

**Abstract:** This project showcases two parallel efforts focused on advancing complex modeling practices. One team explored the automated conversion process from SysMLv1 to SysMLv2 using large language models (LLMs), emphasizing the need for more efficient and accurate modeling workflows. Independently, a second team developed an AI-driven solution to automate SysML-related tasks. They created a Small Language Model (SLM) trained using Retrieval-Augmented Generation (RAG) and fine-tuning on domain-specific SysML metadata. A graph database was built to enhance complex querying and deepen the model's understanding of SysML diagram structures. The SLM processes prompts combining questions and partial diagrams to generate accurate SysMLv2 textual and diagrammatic outputs. Model performance was evaluated by comparing machine-generated results to human-created references, focusing on textual similarity and structural correctness. Together, these efforts demonstrate the potential for both manual and AI-assisted approaches to improve the efficiency, accuracy, and scalability of systems engineering processes.

2:45 PM

**Presentation Title:** Russia's Use of Gendered Disinformation As a Tool of Hybrid Warfare Against the United States

**Sponsored by:** RTX

**Faculty Mentor(s):** Dr. Trevor Wilson

**Student Researcher(s):** Samantha B, Nicole E

**Abstract:** This study aims to examine how gendered disinformation functions as a form of soft power in Russia's broader geopolitical strategy. By framing gender equality and LGBTQ+ rights as existential threats to "traditional values," Russian state and non-state actors manipulate public discourse to weaken trust in democratic institutions and fuel polarization in the U.S. and allied nations. This analysis details how gendered disinformation serves as a form of hybrid warfare, ways gendered disinformation is spread throughout the U.S., as well as Russia's political motivations and strategic purpose.

3:00 PM

**Presentation Title:** Optimized Digital Engineering Transformation

**Sponsored by:** Department of Energy (DoE), National Nuclear Security Administration (NNSA)

**Faculty Mentor(s):** Dr. Paul Wach, Dr. Taylan Topcu, Dr. Nicole Hutchison, Dr. Peter Beling, Dr. Kelli Esser, Carson Sandman

**Student Researcher(s):** Nicholas J, Natalie H, Sydney E

**Abstract:** What comes after the digital transformation? What capabilities should we expect to emerge? What are the enabling technologies? By addressing these questions, this research aims to optimize the digital engineering transformation by considering both the organizational (socio-) and technical facets. Our project has produced an initial analysis framework, a set of actional recommendations, and a roadmap for the sponsor.

3:15 PM

**Presentation Title:** Hydrodynamic Analysis of the Feasibility of Various Control Surface Configurations

**Sponsored by:** Office of Naval Research

**Faculty Mentor(s):** Dr. Lakshmi Miller

**Student Researcher(s):** Jaden N

**Abstract:** This study is a subset of an ONR funded grant led by Dr. Dan Stilwell for Energy aware autonomy Phase I. Here, we study the feasibility of a vectoring thruster capability for the VT-690. We propose a method of comparison that involves obtaining the forces and moments generated on the craft due to control surface deflection. These control surfaces include moving-fixed fins combination or a vectoring thruster. The moving and fixed fin combination is attempted in the X-fin as well as the cruciform fin configuration to explore differences. The vectoring thruster is an off-the-shelf ducted thruster whose only purpose is to be a point of comparison-it does not reflect what an optimized ducted thruster could be. The fins, however, were designed using airfoil geometry to create an advantage in axial drag apart from generated side forces and moments.

# Presentation Abstracts

3:30 PM

**Presentation Title:** Few-Shot Transfer Learning for Spectrum Sensing

**Sponsored by:** Virginia Tech National Security Institute

**Faculty Mentor(s):** Dr. Chris Headley, Dr. Maymoonah Toubeh

**Student Researcher(s):** Caleb M

**Abstract:** Deep learning models have emerged as the state of the art for spectrum sensing applications due to their expressivity, adaptivity, and robustness. In recent years, projects such as the IARPA SCISRS program have continued to emphasize the necessity of highly adaptive algorithms for applications such as anomalous signal detection. To accurately model spectral behaviors in complex propagation environments, deep learning models typically require many labeled samples. However, large-scale over-the-air data collection and labeling is often prohibitively expensive, especially in adversarial or dynamic environments. As a result, developing methods to reduce the number of labeled samples needed to train robust deep learning models is a critical research area. Transfer learning has been shown to be successful in environmental adaptation tasks. Furthermore, prior work has demonstrated the effectiveness of using simulated data to augment spectrum awareness. We hypothesize that models pretrained on simulated data will learn high-level structural characteristics of communications waveforms and realize improved performance on downstream few-shot tasks. By using simulated examples of known representative waveforms to pretrain deep neural networks, we hope to achieve more robust spectrum sensing performance on data collected from previously unseen transmitters.

3:45 PM

**Presentation Title:** 2D Analysis of Forward Facing Step in Hypersonic Flow Using STARCCM+

**Sponsored by:** Northrop Grumman

**Faculty Mentor(s):** Dr. Liselle Joseph

**Student Researcher(s):** Jeffrey F

**Abstract:** A computational fluid dynamics study is presented on hypersonic flow behavior around a forward-facing vertical step protuberance to understand system impacts of manufacturing defects within a scram jet isolator. 30 simulations are run with varying free-stream Mach numbers between 3 and 7 and step heights from 0.25mm to 3mm. The temperature field is analyzed to define correlations for average step face temperature. It is found that shear drag remains nearly constant with increasing step height, while the pressure drag increases close to linearly with total free Mach number and step height. Recommendations are presented for the design of tolerances for scram jet isolator manufacturing.

4:00 PM

**Presentation Title:** Spectral Warrior | Learning RF through VR Gamification

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. William Headley, Dr. Brad Davis, Elliott Rheault

**Student Researcher(s):** Hannah B, Clarence B, Brianna D, Madeline D, Kaden E, Laura J, Jayden K, Espen L, Tobechei O, Casie P, Dillon R, Aditi S, Isaac T, Aditi S.

**Abstract:** Through the virtual reality Spectral Warrior concept, we aim to provide a thorough and detailed learning experience of radio frequency concepts. The player will learn antenna propagation and beamforming concepts and apply what they've learned to jam enemy missiles and protect the integrity of their ship. Through the gamification of radio frequency concepts, we hope to offer a realistic and immersive educational resource for students and workforce training to our sponsor, NSWC Dahlgren.

# Poster Abstracts

**Poster Title:** 2D Analysis of Forward Facing Step in Hypersonic Flow Using STARCCM+

**Sponsored by:** Northrop Grumman

**Faculty Mentor(s):** Dr. Liselle Joseph

**Student Researcher(s):** Jeffrey F

**Abstract:** A computational fluid dynamics study is presented on hypersonic flow behavior around a forward facing vertical step protuberance to understand system impacts of manufacturing defects within a scram jet isolator. 30 simulations are run with varying free-stream Mach numbers between 3 and 7 and step heights from 0.25mm to 3mm. The temperature field is analyzed to define correlations for average step face temperature. It is found that shear drag remains nearly constant with increasing step height, while the pressure drag increases close to linearly with total free mach number and step height. Recommendations are presented for the design of tolerances for scram jet isolator manufacturing.

**Poster Title:** AI/LLMs for Government Contract Automation

**Sponsored by:** Acquisition Innovation Research Center (AIRC)

**Faculty Mentor(s):** Brian Mayer

**Student Researcher(s):** Bradley F, Andrew N

**Abstract:** AI is a powerful tool that can accomplish many tasks and improve what humans can accomplish, but it has its limitations so system development is a deliberate process that should be guided by policy and end use. For many tasks, the critical importance of human judgment means AI should serve as a complementary tool rather than a standalone solution. AI and Generative AI have proven to be useful in a wide variety of administrative tasks automating repetitive processes such as document creation, email drafting, data summarization, and alerting. This research explores the potential to enhance contract and procurement management process methods using AI and LLM pipelines. This poster shows the assessment of several contracting tasks and proposes AI implementations that can assist those who are currently completing the task.

**Poster Title:** Alternative Navigation Methods for GPS Denied Environments

**Sponsored by:** Systems Planning and Analysis (SPA)

**Faculty Mentor(s):** Dr. Austin Phoenix

**Student Researcher(s):** William T, Kasey B, Sean W, Danny C, Joanna H, Jack J, Nicholas D, Nathan H

**Abstract:** Modern society and military operations are increasingly dependent on the Global Positioning System (GPS) for navigation, timing, and coordination. However, this overreliance presents a critical vulnerability, as the GPS system is susceptible to jamming, spoofing, and even large-scale destruction in the event of cyber warfare or kinetic attacks on satellite infrastructure. The loss of GPS could disrupt global commerce, defense operations, and emergency response systems, highlighting the urgent need for resilient alternative navigation solutions.

This project investigates alternative methods to navigate without GPS, ensuring mission success in contested environments. Research focuses on both externally bound systems that rely on outside infrastructure as well as internally unbound systems that are self-contained. Using the findings of this research, this study aims to lay the groundwork for development of a hybrid navigation system that remains operational even in a complete GPS blackout.

**Poster Title:** An Exploratory Analysis of Chinese Malware

**Sponsored by:** DoDCyber Scholarship Program (CySP)

**Faculty Mentor(s):** Dr. Aaron Brantly

**Student Researcher(s):** Ethan D

**Abstract:** Shadowpad is a private backdoor program widely used by Chinese state-sponsored APT groups and is modular, having plugins easily installed and deleted. Plugins are only modifiable by the developer, leading to a product that is distributed in Chinese threat actor groups. Shadowpad has also been widely used in ransomware and espionage attacks on Windows systems by Chinese threat actors since 2015.

**Poster Title:** Atomic Physics Controllers

**Faculty Mentor(s):** Dr. Mark Limes

**Student Researcher(s):** Jack F, James P, Jeb S

**Abstract:** Atomic vapor systems require precision analog electronics to control lasers, temperature, and magnetic fields in order to achieve high-performance magnetic field and inertial sensing in real-world environments. Students will design, implement, and test PCB and flex PCBs for open-loop operation, and if time allows, design and implement ADCs, DACs, and micro-controllers to interface with these analog front ends.

**Poster Title:** Automated Tools for Bayesian Integrated Testing

**Sponsored by:** Director, Operational Test & Evaluation (DOT&E)

**Faculty Mentor(s):** Dr. Justin Krometis, Dan DeCollo

**Student Researcher(s):** Jessica M

**Abstract:** Bayesian analysis is a statistical framework that allows researchers to update beliefs about a quantity of interest based on gathered data using Bayes' Theorem. Unlike traditional frequentist statistics, Bayesian methods incorporate prior information (historical data, expert knowledge, etc.) into data analysis, which leads to a more flexible, integrated approach to test data analysis, as practitioners can decide what data to leverage and how to leverage it. That being said, implementing Bayesian analysis is challenging as it requires specialized skills. However, the development of automated analysis tools can address these barriers and make modern Bayesian techniques more available to a wider, less technical audience. Doing so helps increase the availability of Bayesian methods and has the potential to make decision-making more effective within the Test & Evaluation community. To facilitate this, our team has developed web applications with the Shiny package in R that enables users to analyze data from binary tests. This tool allows users to upload test data, tweak parameters, choose prior distributions, and automatically generate plots and estimates that support test planning and decision making.

## Poster Abstracts

**Poster Title:** Autonomous Multisensor Scanning and 3D Model Generation for Ship Configuration Management

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. John Gilbert

**Student Researcher(s):** Nick A, Nathan R, Leanne L

**Abstract:** When a ship faces a change in configuration, be it damage or a new setup on deck, that requires new engineering analysis it enters a pipeline of work done by hand over a period of months. Our goal is to increase the time efficiency of the naval ship scanning to engineering analyses workflow by automating the point cloud processing and CAD modeling steps previously done by hand. For this year, we are currently focusing on the identification and removal of bad points in point cloud data, along with computer vision for identification and auto-labeling of features in scenes. Additionally, we are generating point cloud scenes and optical images from CAD models, to use for training sets of known models or by direct surface reconstruction, along with improving upon the fidelity of previous work.

**Poster Title:** Can Humans Trust What Machine Learning Sees? Multicategory Recalibration Approaches for Image Classification

**Sponsored by:** Director, Operational Test & Evaluation (DOT&E)

**Faculty Mentor(s):** Dr. Chris Franck

**Student Researcher(s):** Amy V

**Abstract:** Machine-generated probability forecasts have become increasingly popular in aiding decision-making tasks such as image classification and natural language processing. Calibration maps uncalibrated probability forecasts, usually generated via statistical models or through machine learning algorithms, to recalibrated probability forecasts that better reflect the true rates of events. Extending current binary recalibrators to the multicategory case is a multifaceted problem, as some current multicategory classifiers are limited in their ability to detect well calibrated probability forecasts, while others only consider the probability forecasts of the greatest predicted category. We propose the Multicategory Linear Log Odds (MCLLO) Recalibration function, which shifts and scales the log odds of each of the probability forecasts for every observation. Our approach fills in the gap of many current multicategory calibrators due to its ability to detect well calibrated probability forecasts, allowing for parameter estimation and hypothesis testing. We demonstrate the effectiveness of our recalibration function through simulations and by applying recalibration on alligator diet and image classification case studies. We compare MCLLO to two comparator recalibration techniques utilizing both our hypothesis test and existing calibration metrics like Expected Calibration Error.

**Poster Title:** CLOUD-D RF: CLOUD-based Distributed Radio Frequency Spectrum Sensing

**Sponsored by:** Amazon Web Services (AWS), Commonwealth Cyber Initiative (CCI)

**Faculty Mentor(s):** Dr. Alyse Jones, Dr. Maymoonah Toubeh, Dr. Chris Headley, Dr. Stephen Adams

**Student Researcher(s):** Srihan B, Abigail D, Rami G, Akshay P, River T, Dylan G

**Abstract:** In wireless communications, collaborative spectrum sensing is a process that leverages radio frequency (RF) data from multiple RF sensors to make more informed decisions and lower the overall risk of failure in distributed settings. However, most research in collaborative sensing focuses on homogeneous systems using identical sensors, which would not be the case in a real-world wireless setting. Instead, due to differences in physical location, each RF sensor would see different versions of signals propagating in the environment, establishing the need for heterogeneous collaborative spectrum sensing. Hence, this project explores the implementation of collaborative spectrum sensing across heterogeneous sensors, with sensor fusion occurring in the cloud for optimal decision making. Last year, we investigated machine learning-based fusion methods and tested the fused model's ability to perform modulation classification, with a primary goal of optimizing for network bandwidth in regard to next-generation network applications. Our analysis demonstrated that our fusion process was able to optimize the number of features extracted from the heterogeneous sensors according to their varying performance limitations, simulating adverse conditions in a real-world wireless setting. This year, we implemented our framework in hardware for over-the-air testing and for further validation that it can operate in a real-world environment.

**Poster Title:** Commercialization Strategy for Mobile mMIMO

**Sponsored by:** Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E))

**Faculty Mentor(s):** Dr. Daniel Jakubisin

**Student Researcher(s):** Ahad K, Marlaina G, Sean K, Andrew K, Cynthia N, Joshua O, Krishna V

**Abstract:** The Undergraduate project team developed a commercialization strategy for Mobile distributed multiple input, multiple output (mMIMO) which allows multiple devices to jointly transmit and receive a signal for improved speed, range, and reliability utilizing 5G/6G communication technology.

**Poster Title:** Communication Relay System

**Sponsored by:** CACI International Inc.

**Faculty Mentor(s):** Dr. Brad Davis

**Student Researcher(s):** Beginning with a concept of operations this program developed system requirements and constructed two radio frequency relay systems to demonstrate the requirements for signal transmission over-the-air (OTA) in order to enhance reception at shadowed receive locations. A system team produced a requirements document and specification and tracked and contributed to overall relay construction. A communication team implemented the transmission/receive modules using software-defined radios, implementing a binary phase shift keying modulation. A third group investigated and constructed a portable relay whose RF signal chain includes directional antennas, amplifiers, directional couplers, and filters in a shielded enclosure. Additionally, printed circuit boards have been designed and partially constructed for use in future phases (signal chain, health monitoring system and a power supply). Power is drawn from a 9-volt battery and a suitable voltage regulating circuit. On-board the relay, a health monitoring system samples signal power and tracks the power system health. This information is reported OTA back to a web-hosted control system using a Wi-Fi. The control system instantiates a graphical user interface (GUI), accessible by user devices. The GUI can be user configured and will display relay statistics and the messages passed. Future uses include beamforming and MIMO.

## Poster Abstracts

**Poster Title:** Computational Electromagnetic Simulations in Virtual Reality

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. Chris Headley, Dr. Bradley Davis

**Student Researcher(s):** Junior B, Robert V, Ethan M, Sam P, Matthew G

**Abstract:** This project presents the development of immersive Virtual Reality (VR) environments showcasing real-time 1D and 2D Finite Difference Time Domain (FDTD) electromagnetic simulations for educational and training purposes. The 1D simulation models transmission lines, illustrating the behavior of a pulse traveling through coaxial cables with varying impedances, enabling users to visualize impedance mismatches and wave reflections. The 2D simulation demonstrates wave propagation from a horn antenna as it interacts with different geometries and materials. Both simulations were rigorously validated against electromagnetic theory and integrated into an Unreal Engine-powered VR experience featuring gamified elements to enhance user engagement.

**Poster Title:** Computer Experiments for Meta-learning of Machine Learning Models

**Sponsored by:** Director, Operational Test & Evaluation (DOT&E)

**Faculty Mentor(s):** Dr. Chris Franck, Dr. Justin Krometis, Dr. Bobby Gramacy

**Student Researcher(s):** Anna F

**Abstract:** Operationally realistic data to inform machine learning models can be costly to gather. An example is collecting aerial images of rare objects to train an image classifier. Before collecting new data, it is helpful to understand where your model is deficient. For example, it may not be good at identifying rare objects in seasons not well represented in the training data. We offer a way of informing subsequent data acquisition to maximize model performance by leveraging both the toolkit of computer experiments and the metadata describing the circumstances under which the training data was collected (e.g. time of day, location, source). We do this by treating the composition of metadata and the performance of the learner, respectively, as the inputs and outputs of a Gaussian process (GP). The resulting GP fit shows which metadata features yield the best learner performance. We take this a step further by using the GP to inform new data acquisitions, recommending the best circumstances to collect future data. Our method for active learning offers improvements to learner performance as compared to data with randomly selected metadata, which we illustrate on image classification and detection benchmarks.

**Poster Title:** ContentCube

**Sponsored by:** Voyager, Astranis

**Faculty Mentor(s):** Dr. Kevin Schroeder

**Student Researcher(s):** Julia E, Michael E, Nate H, Gracie P, Larsen V

**Abstract:** inspireFly is a Virginia Tech undergraduate CubeSat design team. After being injected into low earth orbit by the Nanoracks ISS CubeSat launcher, inspireFly's 1U CubeSat "ContentCube" will extend a boom arm, activate a display screen, and activate a camera system. After deployment, ContentCube will take "selfies" of itself with the display screen on and earth in the background. The objectives of this mission are to test an OLED display screen in space, to provide an early proof of concept for orbital advertising missions, and to inspire future generations of engineers through photos of themselves in space. Constrained to just a 10x10x10cm cube, ContentCube must fit antennas, batteries, a power board, a telemetry board, a payload board, a display screen, a boom arm, and a camera. ContentCube was handed off to its NASA/Voyager Space launch facilitators in mid-March 2025.

**Poster Title:** Continuously Adaptive Autonomous Systems (RL)

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. Justin Krometis

**Student Researcher(s):** Sahaj S, Rohan V

**Abstract:** The goal of the project is to investigate the effects of environment changes or adversarial actions on learning systems. We are seeking to build a suite of examples in reinforcement learning and computer vision and to understand the factors and actions to which they are sensitive. This describes work to implement a "Capture the Flag" scenario, where defending agents try to protect a position from attacking agents. Both teams of agents are trained to outdo the other using adversarial reinforcement learning. Rewards functions were tuned until both teams of agents achieved reasonable behavior. The resulting policies were then measured to understand their sensitivity assumptions in the training environment. The results of the project will contribute to understanding of autonomous systems that are critical in Naval operations.

**Poster Title:** Converting SysMLv1 to SysMLv2 using GenAI

**Sponsored by:** Naval Engineering Education Consortium (NEEC)

**Faculty Mentor(s):** Dr. Paul Wach, Mary Nerayo

**Student Researcher(s):** Nate W, Alex B, Grant R, Rohan A, Kelechi E, Junior B, Gordon M

**Abstract:** SysML v1 is an outdated Systems Engineering UML Diagram standard used by the Department of Defense. Recently, the DoD has been trying to convert SysML v1 to the newer SysML v2, but it's not easy to do manually. Our goal is to convert this outdated standard into the new SysMLv2 standard using AI.

**Poster Title:** Cyber PIVOTT in Action? Addressing AI Hiring Bias and Skills-Based Gaps in Cybersecurity

**Sponsored by:** ISERCVT

**Faculty Mentor(s):** Dr. Arianna Schuler-Scott

**Student Researcher(s):** Jada-Ane L

**Abstract:** This research explores how the Cyber PIVOTT Act of 2024 addresses cybersecurity workforce shortages by promoting alternative pathways to employment for individuals without traditional four-year degrees. The study focuses on Skilled Through Alternative Routes (STARs), a population that includes veterans, community college students, bootcamp graduates, and career switchers. Drawing from sources including Harvard Business School, the National Bureau of Economic Research, and federal policy documents, this project identifies the barriers STARs face in entering cybersecurity roles, including degree inflation, employer hiring practices, and limited recognition of work experience.

The project includes a risk assessment that maps how different stakeholders—such as underrepresented groups, employers, educators, and federal agencies—are impacted by or involved in these workforce development challenges. The research also analyzes the structure and goals of the Cyber PIVOTT Act, which funds training through certifications and associate degree programs. Findings are organized around four core research questions concerning workforce needs, hiring filters, policy alignment, and equity impacts within cybersecurity hiring.

# Poster Abstracts

**Poster Title:** Data Guardian: Advanced Monitoring for Third-Party Access Points

**Sponsored by:** M.C. Dean

**Faculty Mentor(s):** Colleen Bartos

**Student Researcher(s):** Siddharth R, Sri G, Brandon N, Mahin A

**Abstract:** This research proposes a network security monitoring system utilizing Kismet API and Raspberry Pi hardware to detect and prevent retail data breaches. Motivated by the 2013 Target data breach, which resulted in the theft of 40 million customer credit card records, we propose an automated alert system for detecting suspicious network activities. Our solution focuses on monitoring network behaviors including abnormal data transfers, unauthorized device connections, rogue access points, and point-of-sale system communications. The proposed system employs real-time signals traffic analysis and alert capabilities to identify potential security threats before they escalate into major data breaches.

**Poster Title:** Demonstration of 5G DCI Obfuscation with a Spread Underlay

**Sponsored by:** Lockheed Martin

**Faculty Mentor(s):** Dr. Daniel Jakubisin, Dr. Jeff Reed, Dr. Nishith Tripathi

**Student Researcher(s):** Connor M, Kumar S

**Abstract:** This demonstration explores a novel application of the underlay channel to enhance the security of DCI in 5G networks by integrating XOR obfuscation mechanisms. This approach leverages the underlay channel to securely communicate obfuscation keys only to the UEs that are the intended recipients of the downlink information, thereby reinforcing the protection of critical control information from advanced sniffing and interception attacks. Traditional obfuscation methods for user data have been widely studied and implemented, but the protection of control plane information, such as DCI, remains a critical area for improvement. By ensuring that DCI is obfuscated and the key is securely transmitted via the underlay channel, the risk of interception and exploitation is greatly reduced. Additionally, implementing robust authentication mechanisms and advanced threat detection methods can further enhance the overall security of 5G networks.

**Poster Title:** Design Analysis of a Morphing Aerial/Underwater Craft

**Sponsored by:** National Security Institute IRAD

**Faculty Mentor(s):** Dr. Lakshmi Miller

**Student Researcher(s):** Rudra P, Krish S, Sebastian R

**Abstract:** In this study we explore the feasibility and performance of a hybrid craft in air and water by understanding the drag and lift trade-offs when the craft morphs between two designs. This poster contains two of the four designs generated for the IRAD of Dr. Ted Baron and Dr. Lakshmi Miller. These two designs are simply analyzed in this poster and are not the final recommendations of the larger project.

**Poster Title:** Developing a Spectrum of Gendered Surveillance-Facilitated Targeting

**Sponsored by:** DoDCyber Scholarship Program (CySP)

**Faculty Mentor(s):** Dr. Aaron Brantly

**Student Researcher(s):** Brook S

**Abstract:** Surveillance practices have been used for various purposes from tracking a significant other to monitoring individuals' data to generate profit. Through extensive research efforts, patterns surrounding the utilization of intrusive surveillance tools and instances of co-opting technology by those with malicious intent have emerged; the disproportionate targeting of women by digital means to control and censor the individual is one such example. This work depicts patterns of the weaponization of gender in the digital sphere and its characteristics, oftentimes reliant upon the exploitation of restrictive societal norms within the region. This writing aims to define a spectrum of technology-facilitated abuses used to monitor, intimidate, and harass women globally, ranging from surveillance deployed against an intimate partner to the use of surveillance tools by state and state-like actors. The broad spectrum of surveillance-facilitated targeting, along with specific case studies of abuse covered, signals an alarming trend that threatens the autonomy of women and necessitates further research.

**Poster Title:** Development of an Underwater Acoustic Research Testbed

**Sponsored by:** Griffiss Institute

**Faculty Mentor(s):** Dr. Justin Kauffman, Dan Sobien

**Student Researcher(s):** Nadeem H, Carson L, Sully M, Mridula T, Shayan R

**Abstract:** Underwater acoustic communication poses substantial challenges, including significant scattering, absorption, refraction, multipath propagation, and noise, highlighting the need for more research in the field. Testing underwater acoustic hardware often requires access to remote locations like ponds, lakes, or oceans, making it logistically challenging. This project aims to develop a permanent, in-lab underwater acoustic testbed for efficient waveform, modulation, and algorithm development, with the eventual goal being to use the testbed to evaluate the effectiveness of anti-jamming algorithms. The testbed was designed and constructed using off-the-shelf components and software defined radios. Initial channel sounding results from the testbed indicate significant multipath propagation, necessitating the need for multipath mitigation techniques.

**Poster Title:** Enhancing Global Security: Ethiopia & Bhutan

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Megan I, Joshua C, Daniel S, Luis S, Micaela W, Lucas B, Vy H, Ella W, Tiphany P, Milo S

**Abstract:** Based on our threat assessments of Ethiopia and Bhutan, we have developed a system to determine the key factors to assess when considering a state for inclusion in the EXBS program. These factors include: Legal and Policy Frameworks on Arms Transfers, Border Security Analysis, Current Arms Smuggling and WMD Access, Economic and Political Motivations, and Threat Environment and Regional Dynamics. By assessing these elements, we can prioritize states that require immediate attention and intervention through the EXBS program, ensuring a more targeted and effective approach to strengthening global security.

## Poster Abstracts

**Poster Title:** Establishing a Wargaming and Crisis Simulations Capability at Virginia Tech

**Sponsored by:** Acquisition Innovation Research Center (AIRC)

**Faculty Mentor(s):** Jamie Cogbill

**Student Researcher(s):** Jeremy C, Corey C, Xander E, Michael M, Mahima S

**Abstract:** The student researchers for this AIRC-funded innovation project sought to establish a wargaming and crisis simulations capability at Virginia Tech where various groups can access simulation-based, role-playing, and cybersecurity educational experiences. The Wargaming Center will use the state-of-the-art Integrated Security Education and Research Center (ISERC) as the platform for exercises that provide experiential learning in areas such as crisis response, national strategy, policy making, and cyber operations. The student researchers investigated options for wargaming and crisis simulations across the government and academia. Ultimately, the research team recommended establishing an office or Wargaming Center at Virginia Tech to provide wargaming or crisis simulation capabilities to faculty and student groups to facilitate experiential learning. Such an office could be centrally funded (i.e., grants) or provided through a “pay-to-play” format where organizations self-fund their own wargaming. One outcome of the project was the group assisted in submitting a grant proposal for \$150,000 to the DoD Cyber Service Academy to continue efforts to establish a cyber and wargaming capability at Virginia Tech. Also, the group helped host a wargame with over 400 Cadets in the ISERC as a test of the capability. Lastly, the group renewed interest among university stakeholders in establishing this capability.

**Poster Title:** Estimating Asymptotic Mixing Rate of Random Walks and Security of Isogeny Protocols

**Faculty Mentor(s):** Dr. Travis Morrison

**Student Researcher(s):** William M

**Abstract:** In this poster we explain how random walks in graphs are related to the family of post-quantum cryptography schemes known as isogeny cryptography, and we detail our contributions to approximating how close to random random walks in isogeny graphs are and how to use this to approximate security of isogeny cryptography schemes.

**Poster Title:** European Perspectives on Drones: Laws, Regulations, Ethics, & Use

**Sponsored by:** Center for European Union and Transatlantic Studies

**Faculty Mentor(s):** Dr. Aaron Brantly

**Student Researcher(s):** Carolyn A, Kat P, Nina L

**Abstract:** With the emergence of drones in both the civilian and military sectors in the European Union (EU), it is essential to question the extent to which EU policies and ethics come into practice. Many concerns are raised with the ethics and regulations of drone usage in both sectors. Concerns around drones involve privacy invasion, stealing of personal data, employment, and asymmetric warfare regarding military use. To address concerns regarding drones, it is essential for the EU to create policies and regulations that better define drone use, data protection, privacy rights, and military ethical use. Drone policies must be accepted by civilians and service members to ensure sustainability. This poster analyzes drone ethics and policies in the EU.

**Poster Title:** Fast ROMs for Complex Shock Structures in Scramjets

**Sponsored by:** US Air Force Academy

**Faculty Mentor(s):** Dr. John Gilbert

**Student Researcher(s):** Roy G, Aaron P

**Abstract:** Accurately modeling shock-dominated flows in scramjet inlets is critical for rapid design and optimization but remains computationally expensive using high-fidelity CFD. This work presents a Shape-Matching Reduced-Order Modeling (SM-ROM) approach for fast and accurate prediction of complex shock structures in dual-mode scramjet inlets. The method segments the flow domain along evolving shock boundaries and uses functional mappings to track changes in geometry and flow features across parameter variations. We demonstrate the SM-ROM on a canonical 2D forward-facing step problem at Mach 3.67, comparing results with full CFD and a traditional POD-Galerkin ROM. The SM-ROM captures key flow structures with significantly lower error and computational cost. Visualizations highlight the ability of the SM-ROM to resolve discontinuities and track domain evolution, while error fields reveal major improvements over POD-Galerkin in both accuracy and robustness. This work enables rapid exploration of inlet designs and lays the foundation for real-time performance prediction and optimization of scramjet components.

**Poster Title:** Federated Learning in Heart Disease Detection

**Sponsored by:** VICEROY

**Faculty Mentor(s):** Dr. Musbah Abdulgader (NSU), William Hanley

**Student Researcher(s):** Pranay J, Farhan H, Julia M, Abdul S

**Abstract:** Heart disease remains one of the leading causes of mortality worldwide. Machine learning (ML) has shown promise in early detection and diagnosis, but traditional ML approaches require centralized data collection, raising privacy and security concerns. Federated Learning (FL) is a decentralized ML technique that enables multiple institutions to collaboratively train models without sharing sensitive patient data.

**Poster Title:** Few-Shot Transfer Learning for Spectrum Sensing

**Faculty Mentor(s):** Dr. Chris Headley, Dr. Maymoonah Toubeh

**Student Researcher(s):** Caleb M

**Abstract:** Deep learning models have emerged as the state of the art for spectrum sensing applications due to their expressivity, adaptivity, and robustness. In recent years, projects such as the IARPA SCISRS program have continued to emphasize the necessity of highly adaptive algorithms for applications such as anomalous signal detection. To accurately model spectral behaviors in complex propagation environments, deep learning models typically require many labeled samples. However, large-scale over-the-air data collection and labeling is often prohibitively expensive, especially in adversarial or dynamic environments. As a result, developing methods to reduce the number of labeled samples needed to train robust deep learning models is a critical research area. Transfer learning has been shown to be successful in environmental adaptation tasks. Furthermore, prior work has demonstrated the effectiveness of using simulated data to augment spectrum awareness. We hypothesize that models pretrained on simulated data will learn high-level structural characteristics of communications waveforms and realize improved performance on downstream few-shot tasks. By using simulated examples of known representative waveforms to pretrain deep neural networks, we hope to achieve more robust spectrum sensing performance on data collected from previously unseen transmitters.

## Poster Abstracts

**Poster Title:** FluxSat

**Faculty Mentor(s):** Dr. Kevin Schroeder

**Student Researcher(s):** Arijeet B, Jacob D, Hadley F, Cristian J, Michael K, Nicholas L, Brandon Y

**Abstract:** This mission aims to evaluate the potential of harnessing the Earth's magnetic field to generate power for satellites. The mission's CubeSat will measure the voltage induced by the electromotive force as it passes through variances in the Earth's magnetic field, also generating a current in the solenoidal payload following Ohm's Law. These results will indicate the feasibility of using planets' magnetic fields as an alternative power source for future satellite missions, as well as its reliability as a backup power source. This would be highly useful for outer solar system and deep space missions as these environments typically include stronger magnetic fields and less sunlight exposure, limiting the efficiency of solar panels and exaggerating the effectiveness of this payload. Preliminary feasibility studies and calculations have shown the merit of this mission, as they indicate that current generation under these conditions is possible.

**Poster Title:** Forward-Learning Communications

**Sponsored by:** Office of Naval Research

**Faculty Mentor(s):** Dr. Joseph Gaeddert, Dr. Maymoonah Toubeh

**Student Researcher(s):** Joshua E, Andy L, Anthony M, Declan R, Shreya T, Martin W, Caleb M

**Abstract:** A team of six VT NSI undergraduate researchers have assembled a poster and demonstration for the 2025 Colloquium in which a deep convolutional neural network machine-learning model is trained on spectrogram data to detect Wi-Fi transmissions and identify new signals it has not previously seen. The demonstration runs on commercial off-the-shelf software-defined radio hardware to showcase real-time spectrum estimation and model inference on S-band signals. A nearby transmitter is used to emit modified Wi-Fi signals the model has never seen. The model identifies these as new variants and displays them separately. The demonstration operates in the 2.54 GHz unlicensed ISM band using open protocols and conventional techniques found in the open literature.

**Poster Title:** GenAI and Digital Transformation

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division, SEC, Office of the Under Secretary of Defense for Research and Engineering (OUSDR&E)

**Faculty Mentor(s):** Dr. Paul Wach, Mary Nerayo

**Student Researcher(s):** Brady J, Caleb A, Cat P, Adithya I, Bhargav A, Bhavya S, Cameron C

**Abstract:** Having previously displayed mainstream LLM capabilities in digital transformation with SysMLv2 code creation, this year we pivot towards hosting LLMs/SLMs locally. This enables us to collaboratively develop our own toolset with no additional subscription costs. Additionally allows for usage of Controlled Unclassified (CU) and Controlled Declassified (CDI) information in the future.

**Poster Title:** Generative MBSE Assistant

**Faculty Mentor(s):** Dr. Paul Wach

**Student Researcher(s):** Adi I, Cameron C, Bhargav A, Bhavya S

**Abstract:** This project explores the integration of artificial intelligence in Systems Engineering to support and automate key tasks. The primary goal is to develop an AI assistant capable of addressing Systems Engineering queries and aiding practitioners in design, analysis, and verification activities. The research focuses on identifying effective pathways for AI adoption within the discipline and leveraging AI to extract insight into core system elements—specifically: (1) system designs, (2) verification requirements and models, and (3) morphisms derived from system requirements. The outcome aims to inform future AI-augmented workflows that enhance efficiency, consistency, and traceability in complex systems development.

**Poster Title:** GPS Spoofing Detection

**Sponsored by:** VICEROY, USDR&E

**Faculty Mentor(s):** Dr. Chunsheng Xin (ODU), William Hanley

**Student Researcher(s):** Devin M, Randy F, Joelle A, Jandra T, Previous U

**Abstract:** GPS spoofing interferes with signals to deceive navigation systems, posing significant cybersecurity risks. Conventional defenses often require extensive infrastructure modifications or large-scale monitoring, limiting their practicality. Our research introduces a mobile solution that leverages sensor fusion and deep learning to detect spoofing effectively.

We employ DeepPOSE—a convolutional neural network that employs long short-term memory—to extract speed and direction from motion sensor data. This algorithm reconstructs trajectories that are then compared with reported GPS logs. We enhance accuracy by applying filters to reduce noise and aligning sensor data with OpenStreetMap to correct errors.

Our method improved position accuracy dramatically, reducing the average displacement error from 902 meters to 26.8 meters. Additionally, the spoofing detection achieved 88% accuracy with a 4% false alarm rate, while map-based alignment further refined trajectory matching.

Future work will focus on refining trajectory reconstruction, integrating additional sensors, and optimizing deep learning models for real-time processing. Extensive testing across varying environments, along with industry and government collaboration, will support deployment in military operations, autonomous vehicles, and other navigation-dependent applications.

**Poster Title:** Graph vs. Relational Databases for RAG in Systems Engineering

**Sponsored by:** Naval Engineering Education Consortium (NEEC)

**Faculty Mentor(s):** Dr. Paul Wach, Mary Nerayo

**Student Researcher(s):** Cat P, Kelechi E

**Abstract:** This research evaluates Retrieval-Augmented Generation (RAG) using Graph-based (Neo4j) and Relational-based (PostgreSQL) architectures for systems engineering knowledge retrieval. Using the Bulldog dataset, we compare two RAG pipelines—one leveraging graph traversal and the other SQL-based queries—both integrated with a small language model (SLM), including a fine-tuned version. Performance is measured via query latency, precision-recall, BERTScore, MAUVE, and scalability tests. Findings will guide AI-driven decision support and knowledge management, advancing digital transformation in systems engineering.

## Poster Abstracts

**Poster Title:** How will AI affect the Cybersecurity Job Market?

**Sponsored by:** ISERC

**Faculty Mentor(s):** Dr. Arianna Schuler Scott

**Student Researcher(s):** Tania L, Jada-Ane L, Hanna T

**Abstract:** AI is an evolving technology that we think heavily affects the technology job market. Understanding the possible ways in which AI might redefine this market will better aid candidates in the field to prepare for any upcoming changes and illuminate the risks for employers. This work also aims to raise awareness because many may not realize the impact of AI in this space. We define AI in this project as: a technology enabling machines to simulate human intelligence in learning, problem-solving, and decision-making. 1, 2. We focus on potential risks, consequences, and outcomes.

**Poster Title:** Hydrodynamic Analysis of the feasibility of various control surface configurations

**Sponsored by:** Office of Naval Research

**Faculty Mentor(s):** Dr. Lakshmi Miller

**Student Researcher(s):** Jaden N

**Abstract:** This study is a subset of an ONR funded grant led by Dr. Dan Stilwell for Energy aware autonomy Phase 1. Here, we study the feasibility of a vectoring thruster capability for the VT-690. We propose a method of comparison that involves obtaining the forces and moments generated on the craft due to control surface deflection. These control surfaces include moving-fixed fins combination or a vectoring thruster. The moving and fixed fin combination is attempted in the X-fin as well as the cruciform fin configuration to explore differences. The vectoring thruster is an off-the-shelf ducted thruster whose only purpose is to be a point of comparison-it does not reflect what an optimized ducted thruster could be. The fins, however, were designed using airfoil geometry to create an advantage in axial drag apart from generated side forces and moments.

**Poster Title:** Integration of High-Altitude Balloon Dynamics into AFSIM

**Sponsored by:** The Aerospace Corporation

**Faculty Mentor(s):** Dr. Kevin Schroeder

**Student Researcher(s):** Ashtyn F, Brian V, Ginny S

**Abstract:** High-altitude balloons (HABs) are relatively simple and cost-effective tools for near-space research and atmospheric science. This project aims to model and simulate the dynamics of latex, zero-pressure, and super-pressure balloons within the Advanced Framework for Simulation, Integration, and Modeling (AFSIM) software. Modeling HAB dynamics in AFSIM will expand its capabilities, allowing for improved analysis and simulation of HAB missions.

This project explores the governing equations for HAB motion and how they can be implemented in AFSIM. Simple models like the SondeHub predictor are adapted and implemented along with more complex dynamic and thermal modeling. The integration of these HAB dynamics into AFSIM allows for various example scenarios to be developed, including balloon flight prediction and ground station location prediction.

Incorporating multiple models for a wide variety of balloon types enhances simulation capabilities, with latex balloons being relevant for short-duration, light-payload weight missions, and zero-pressure and super-pressure balloons being relevant for long-duration, heavy-payload weight missions. Incorporating these models into AFSIM advances its mission planning capabilities and applications.

**Poster Title:** IntelBuddy: Designing An AI Agent to Perform OSINT Discovery and Verification Tasks

**Faculty Mentor(s):** Dr. Kurt Luther

**Student Researcher(s):** Sutton M, Fernando B

**Abstract:** Open source intelligence (OSINT) investigations use publicly available information (PAI) to gather intelligence for use in fields such as cybersecurity, law enforcement, and national security. Investigators often face difficulty identifying relevant information from the large volumes of data available online. Furthermore, they can spend an excessive amount of time preparing the input and processing the output of data collection tools. Once data is collected, it must be verified from multiple sources to confirm its investigative value and improve the reliability of data at the cost of efficiency. This project introduces IntelBuddy, an OSINT Artificial Intelligence (AI) agent to minimize these inefficiencies and streamline the investigative process through assisted data collection and verification. The agent supports a wide variety of OSINT-related tasks related to cyber vulnerability assessments, such as network enumeration, breach data identification, and brand monitoring. After receiving a user prompt, the agent deduces which data is requested and retrieves it from trusted sources using APIs. To combat transparency issues arising from the use of black-box LLMs and to enhance confidence in the results, the agent provides step-by-step explanations detailing data collection tasks and source listings to improve the agent's credibility. Future work plans include user testing with OSINT professionals.

**Poster Title:** Interpretable AI for Animal Behavior

**Sponsored by:** Griffiss Institute

**Faculty Mentor(s):** Dr. Jin Hee Cho, William Hanley

**Student Researcher(s):** Dian C, Raj K, Angelie N

**Abstract:** Monitoring the health and behavior of farm animals is essential for controlling disease outbreaks, sustaining food production, and minimizing economic risks. However, real-world disease detection systems face challenges such as imbalanced datasets and the lack of interpretability in deep learning models, making it difficult for farmers and veterinarians to trust AI-generated predictions. To address these challenges, we will integrate explainable AI (XAI) techniques into a Bayesian framework for disease detection in farm animals.

## Poster Abstracts

**Poster Title:** Is NATO More Than Article V?: Furthering Understanding of Civilian Opportunities

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Jess G, Thomas Q, Cameron U, Melanie G, Will H, Caroline H, Miabella W, Natalie S, Logan K, Sean K, Eric L, Haleigh H, Marlaina G, Matthew Q, Matthew S, Dori V, Alex A, Elena R

**Abstract:** Commissioned by the U.S. Department of State, specifically the Public Diplomacy section of the Embassy in Helsinki, this project seeks to identify strengths and potential avenues for partnership and leadership within the context of Finland's recent accession to NATO.

Given that accession was predicated primarily upon countering Russian security threat, the Embassy expressed interest in determining opportunities to involve Finnish citizens in civilian-led NATO initiatives, including opportunities for employment, education, internships, service, and international engagement. The Embassy also requested that students determine opportunities to maximize Finnish military strategy and deterrence through a NATO-collaborative frame, while emphasizing a desire to assess and consider the opinions of Finnish citizens on the implementation of the above and further NATO-led initiatives.

Students considered opportunities for Finnish leadership and NATO/U.S. collaboration within a Women, Peace, and Security (WPS) framework, and developed recommendations aligning with the shared initiatives of the Finnish government, NATO, and WPS.

**Poster Title:** Is NATO More Than Article V? - Furthering Understanding of Civilian Opportunities Through Distributed Survey Analysis

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Elena R, Patrick L, Abby J, Haleigh H, Will H, Marlaina G, Olivia P, Christian R

**Abstract:** This project was part of the Is NATO More Than Article V? - Furthering Understanding of Civilian Opportunities Through Distributed Survey Analysis. We conducted a survey in Finland regarding Finnish citizens' understanding of NATO. From the survey results, we better understood Finnish public opinion on women in military roles and NATO relations.

**Poster Title:** Islamic Violent Extremism in Latin America and the Caribbean: An Examination of Foreign Terrorist Organization in the Region

**Sponsored by:** National Intelligence University

**Faculty Mentor(s):** Dr. Stacey Pollard, Colleen Bartos

**Student Researcher(s):** Kyle S, Haleigh H

**Abstract:** The decades-long issue of the infiltration of borders in numerous Latin American and Caribbean countries has yet to be effectively addressed. Thousands of fighters each year, across these countries, flee to the Middle East and North Africa (MENA) in support of various jihadist causes, while thousands more remain local to carry out violent attacks and spread extremist values within their own borders. This infiltration has been exacerbated by the rise of the digital media age, otherwise known as the "Cybercaliphate," which has played a massive part in the recruitment, retention, and overall spread of terrorist cell ideals. Since this issue continues to be an ongoing threat to civilians, our area of research employed a specific focus on Latin America and the Caribbean to investigate the potential presence of Hezbollah and other various terrorist organizations in these areas. Members of Hezbollah and other terrorist cells have maintained a distinct presence among international boundaries, oftentimes extending their reach beyond their home capabilities within MENA. A prominent issue that was addressed is the influence of violent extremism and the activities that are taking place in the Tri-Border Area (TBA). In order to gain a better understanding of all that is taking place in these regions, social media and its role in disseminating information, as well as the evaluation of the facilitation of intelligence networks, was analyzed.

**Poster Title:** Kessler Run

**Faculty Mentor(s):** Dr. Kevin Schroeder

**Student Researcher(s):** Sean R, Kareem B, Tyler O, Rishi N, Dom C

**Abstract:** The goal of our mission is to create a sustainable 3U CubeSat that will measure and track space debris during the active portion of its life cycle, and exit its orbit preemptively, tracking it along the way. This would advance the capabilities of InspireFly's CubeSat program utilizing new sensors as well as tracking and reporting data on one of the biggest threats to space programs globally. Data tracked would optimally include kinematic data, which ground station could use to map and predict the location the debris discovered by the CubeSat, as well as quantity and size of debris. The mission will also test a de-orbit mechanism, tracking the CubeSat's early descent, furthering research in sustainability for small space programs. This data will be compared to the predicted natural de-orbit of the CubeSat to determine the effectiveness of the de-orbit mechanism. These two main objectives, tracking debris and de-orbiting, will prove an engaging challenge for InspireFly members during its development, and challenge them to use information learned through ContentCube's development to design InspireFly's first 3U CubeSat.

**Poster Title:** Leveraging OSINT to Map PRC University Partnerships Globally

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Ally S, Amanda G, Asher M, Ashley W, Avery T, Breanna W, Caleb F, Dante P, Emery M, Emil M, Emily C, Ethan D, Grace J, Harper C, Kyle H, Laura L, Lily B, Lily T, Luke P, Michael W, Noah K, Rabihah W, Rachel W, Sydney D, Taylor B, Will E, Supervisors: Cameron P, Liz M

**Abstract:** The PRC leverages MOUs between Chinese and foreign universities and research partnerships as means to gain access to potentially dual-use research, data, technology, and equipment - particularly research, data, technology, and equipment relating to emerging technologies. Due to the public facing nature of these research partnerships, open-source data can be leveraged to map the PRC's network of MOUs and research partnerships. This project leverages this open-source information to identify and document partnerships, joint laboratories, and MOUs between universities in the People's Republic of China (PRC) and other universities globally.

## Poster Abstracts

**Poster Title:** LLMs for Modeling Cyber Resilient Offshore Wind Farms

**Sponsored by:** Office of the Under Secretary of Defense for Research and Engineering (OUSD(R&E))

**Faculty Mentor(s):** Dr. Paul Wach, Mary Nerayo

**Student Researcher(s):** Grant R, Rohan A, Kelechi E, Junior B, Gordon M

**Abstract:** This project investigates the use of large language models (LLMs) as copilots in model-based systems engineering (MBSE), specifically for generating SysMLv2 models that support cyber-physical resilience in wind farm systems. Undergraduate researchers self-hosted and fine-tuned StarCoder, an open-source small language model, using the STEDE platform. Students integrated prompt engineering with domain-specific data—including graph-based knowledge from Neo4j—to guide SysMLv2 model generation. Outputs were quantitatively compared to human-generated diagrams and code, revealing strong structural alignment and occasional optimizations. This work demonstrates how LLMs can support learning and model development, making advanced MBSE workflows more accessible and scalable.

**Poster Title:** Machine Learning for Radar Clutter Differentiation

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. Justin Krometis

**Student Researcher(s):** William D

**Abstract:** Understanding the radar signatures of ambient objects and how to differentiate them from targets that the radar would like to detect has been an important topic in the design of air defense systems for decades. Radar clutter is the scattering of signals off of objects that are secondary to the mission of the system and have the potential to obscure or draw attention away from objects that the radar system is tasked to detect. These objects can either be surface-based, such as mountains, buildings, or sea spikes, or airborne/volumetric, such as precipitation, birds, insects, or chaff.

This project will seek to develop machine learning-based algorithms for mitigating clutter in shipboard radar systems. Working with real radar data from the U.S. Navy and in collaboration with experts at Naval Surface Warfare Center Dahlgren Division, project researchers will seek to develop an approach to characterizing radar outputs that is automated, accurate, and robust. The long-term goal will be to build an algorithm capable of being integrated into shipboard collection systems to improve the Navy's situational awareness and translate big datasets into a strategic advantage.

**Poster Title:** Maneuver Detection

**Sponsored by:** Intelsat

**Faculty Mentor(s):** Dr. Kevin Schroeder, Monty Campbell, Charlotte Lowdermilk

**Student Researcher(s):** Herwen X

**Abstract:** Virginia Tech National Security Institute (VTNSI) is conducting a proof-of-concept study focused on tracking a resident space object (RSO) designated by the sponsor(Intelsat). Using sponsor-provided data, VTNSI will task its rooftop telescope to collect observational data, evaluate system performance, and suggest improvements. Parallel efforts will use the RESOMAKE (RESponsive Space Observation, Modeling, Analysis, and Kinetics Estimation) tool to simulate RSO orbits and inject synthetic maneuvers. The goal is to detect these maneuvers and estimate their timing, direction, and magnitude as well as determine the optimal configurations to detect said maneuvers.

**Poster Title:** MASTIFF: Malicious Adversarial Sensing Techniques for Isolating Friend and Foe

**Sponsored by:** Peraton

**Faculty Mentor(s):** Dr. Maymoonah Toubeh, Dr. Alyse Jones

**Student Researcher(s):** Joey C

**Abstract:** Radio Frequency Machine Learning (RFML) models are vulnerable to Adversarial Machine Learning (AML) attacks (poisoning, evasion, etc.). There is a lack of Test and Evaluation (T&E) for the effects of an adversary on RFML models. MASTIFF (Malicious Adversarial Sensing Techniques for Isolating Friend and Foe) is a joint effort with VTNSI and Peraton to address this issue. We developed a novel Reinforcement Learning (RL) framework for testing the robustness of RFML models used in detection, classification, and identification. This is the first RL framework to tackle red teaming in a crucial step toward securing ML in the RF domain. In Phase I, we created a data generation tool focused on realistic waveforms (Wi-Fi, ZigBee, and Bluetooth). We also produced a notional Model Under Test (MUT) sensor trained on synthetic data. For the sensor, we developed adversarial agents focused on evasion attacks (lowering power & shifting bandwidth) and formed reward function based on metrics generated by MUT's detection. In Phase II, we are designing harder tests with less assumptions (transitioning away from white box assumption), as well as expanding adversarial agent with a modular set of signal-based, environment-based attack types, and support for raw I/Q based data types.

**Poster Title:** Mobile Reverse Engineering and Vulnerability Detection

**Sponsored by:** L3Harris Technologies

**Faculty Mentor(s):** Dr. Mark Thompson

**Student Researcher(s):** Alexander K, Cameron M

**Abstract:** Modern iOS applications implement strict security mechanisms, such as sandboxing, code signing, and memory protections, to prevent unauthorized modifications to apps and ensure data integrity. Our research project focuses on reverse engineering iOS messaging applications, specifically those that natively process SMS and RCS messages, to analyze their security protocols and identify potential vulnerabilities.

Our approach involves using Ghidra to statically analyze Mach-O binaries, dynamic analysis using Xcode, and patching techniques to modify apps directly. Our goal is to develop patches that potentially uncover otherwise hidden information or open up a vulnerability.

Some challenges of this project include working without a jailbroken device, overcoming Apple's automatic encryption of app binaries, and handling iOS's strict signature requirements.

## Poster Abstracts

**Poster Title:** Modernizing Vue: Upgrading from Vue 2 to Vue 3 with Vite

**Sponsored by:** SAP NS2

**Faculty Mentor(s):** Tiasha Khan

**Student Researcher(s):** Emily V, Aashish A

**Abstract:** Modern web applications rely on frameworks and build tools to ensure smooth performance, maintainability, and scalability. SAP NS2's codebase was built using Vue 2 (a JavaScript framework) and Webpack (a tool that processes and optimizes code), but these older technologies are slower and less efficient for modern development. To improve performance, we upgraded to Vue 3 and Vite.

**Poster Title:** Navigating the Cybersecurity Job Market: The Impact on Career Opportunities for New Graduate Women of Color

**Sponsored by:** ISERC

**Faculty Mentor(s):** Dr. Arianna Schuller Scott

**Student Researcher(s):** Hanna T

**Abstract:** While there is an increase in the need for cybersecurity professionals, access to these opportunities remains unequal for new women of color graduates in this field. By analyzing structural barriers, organizational commitments to diversity, and AI biases, this research seeks to uncover the gaps between policy and practices.

**Poster Title:** NetGen-AgentGen: LLM-enabled Bootstrapping Tool for RL-enabled Network Pen-testing

**Sponsored by:** Director, Operational Test & Evaluation (DOT&E)

**Faculty Mentor(s):** Emma Meno

**Student Researcher(s):** Connor N, William B, Justin J, Hemansh A, Colleen P

**Abstract:** The goal of this project is to improve the network penetration-testing (pen-testing) process using reinforcement learning (RL). This project was broken into two sub-teams: AgentGen and NetGen. AgentGen implemented RL pen-testing agents. NetGen developed a large language model (LLM)-based bootstrapping tool to enable more accessible network configuration generation for comprehensive training and evaluation data.

**Poster Title:** Night's Watch: A Virtual C-UAS Testbed

**Sponsored by:** ARMY DEVCOM C5ISR

**Faculty Mentor(s):** Dr. John Gilbert, Dr. Austin Phoenix, Collin Phillips

**Student Researcher(s):** Aayan A, Ryan A, Alexander B, Ethan D, Kaiden D, Vincent F, Gautam I, Utsav M, Matthew M, Ronit M, Sunjeet N, Sanjay S, Nico T, Garrett W

**Abstract:** The Counter-UAS Testing and Research Center (CTRC) is a joint effort between VTNSI and the Mid-Atlantic Aviation Partnership (MAAP), funded by the U.S. Army to advance academic capabilities in countering evolving unmanned aerial threats. This poster presents the development of a modular, virtual environment designed to simulate complex UAS and C-UAS engagements beyond the limits of physical testing. The framework supports many-vs-many scenarios, sensor and countermeasure modeling, and reinforcement learning integration, with connectivity to real-world indoor and outdoor test ranges. Our goal is to accelerate the development and validation of adaptive, intelligent C-UAS systems for national security applications.

**Poster Title:** Open-Source Analyst Methodologies: Russia/Ukraine Conflict

**Sponsored by:** Senior Military Colleges Cyber Institute

**Faculty Mentor(s):** William Hanley

**Student Researcher(s):** Jordan B, Jake F

**Abstract:** What is an open-source analyst and what kinds of tools do they use? We conducted a case study analyzing Russian media in the wake of the Russia-Ukraine conflict with the objective of identifying the utility of different open-source tools. From our study, we evaluated the tools that were used to see which were useful and where they may be of use to an open-source analyst.

**Poster Title:** Operation Safe Passage, Digital Engineering for T&E

**Sponsored by:** Director, Operational Test & Evaluation (DOT&E)

**Faculty Mentor(s):** Dr. Paul Wach

**Student Researcher(s):** Emanuel O, Austin L, Trevor I, Walter L, Winston M, Allegra O, Robert S, Liam S, Brandt S

**Abstract:** Operation Safe Passage advances T&E methods by leveraging Digital Engineering (DE) to develop unmanned systems that ensure safe travel through contested, mined areas.

**Poster Title:** Optimized Digital Engineering Transformation

**Sponsored by:** National Nuclear Security Administration (NNSA) /DOE

**Faculty Mentor(s):** Dr. Paul Wach, Dr. Taylan Topcu, Dr. Nicole Hutchison, Dr. Peter Beling, Dr. Kelli Esser

**Student Researcher(s):** Nicholas J., Natalie H., Sydney E.

**Abstract:** The objective of our research is to model the acquisition process and the factors influencing decision-making. The goal is to use real-world data to assign probabilistic values to each decision-making agent, with the primary aim of increasing the fidelity of our model.

## Poster Abstracts

**Poster Title:** Phased Array & Visualization

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. Brad Davis

**Student Researcher(s):** Nick B, Abraham T, Sam S, Ian B, Vanessa B, Joseph N, Alexander J, Kyle W, Zachary V, Reve M

**Abstract:** Beginning with a 16 element, 4x4 array from last year, the team has expanded this project by incorporating an RF signal chain feeding each element. Including the radiating elements, this RF front-end is typically referred to as a [Passive] Phased Array. The RF components behind each element instantiates a Transmit/Receive (T/R) module. The team has constructed a semi-active T/R module where each element T/R includes RF amplification in transmit and receive channels; however, the source is not integrated with each element's RF components. In our first iteration, we have constructed the T/R modules using connectorized components for a 1x4 linear array. Here, the T/R module is divided into transmit and receive signal paths joined at the radiator by a custom-designed circulator PCB. Each channel (Tx and Rx) also includes phase shifters, limiters and bandpass filtering; the phase shifters also are custom-mounted on a PCB. The fully integrated 16-element phased array has been partially constructed using a modular combination of the T/R modules. All 16 antenna elements and T/R modules are integrated into a custom designed and configured backplane with integrated power and control signaling. Intended future applications include FMCW and pulsed radar, communications, and electronic warfare.

**Poster Title:** Project IRIS: Intelligent RF Identification System

**Sponsored by:** Commonwealth Cyber Initiative (CCI)

**Faculty Mentor(s):** Dr. Maymoonah Toubeh, Dr. Alyse Jones, Dr. Chris Headley, Dr. Stephen Adams

**Student Researcher(s):** Dylan G, Justin R, Brady F, Cora W, Miles T

**Abstract:** Our work focuses on Radio Frequency (RF) fingerprinting for Specific Emitter Identification (SEI) by identifying subtle differences between homogeneous transmitters using RF signals under varying nuisance parameters. This research builds upon previous work by VTNSI, which developed the Blind User Reconfigurable Platform (BURP) — a system capable of generating a high volume of RF transmissions. These signals are then captured by a set of four distinct receivers. The goal of this work is to produce a publicly available and reusable dataset for Specific Emitter Identification (SEI) and RF fingerprinting research. We also plan to create a fusion model that will take into account receiver heterogeneity, hypothesizing will result in higher accuracies and increased generalization.

**Poster Title:** Project Management Innovation Projects

**Sponsored by:** Acquisition Innovation Research Center (AIRC)

**Faculty Mentor(s):** Geoffrey Kerr

**Student Researcher(s):** Mahima S, Colleen P, Ahad K, Muhammad (Shayan) R, Emmanuel O, Gordon M

**Abstract:** A team of student project managers that learned the basics of project management and led an undergraduate student innovation project over an academic year. The team was responsible to establish a project baseline and manage cost, technical, and schedule aspects of the project while identifying and managing the associated risks.

**Poster Title:** Quantum Approaches to the Quadratic Assignment Problem

**Sponsored by:** Naval Engineering Education Consortium

**Faculty Mentor(s):** Ehren Hill

**Student Researcher(s):** Nathan D, Julia S

**Abstract:** The Quadratic Assignment Problem (QAP) is an NP-hard fundamental combinatorial optimization problem and was introduced by Koopmans and Beckmann in 1957. The problem is to assign  $n$  facilities to  $n$  different locations with the goal of minimizing the cost associated with the assignments. We initiate the study of using Rydberg arrays to find optimal solutions to the QAP and provide a complementing circuit theory to facilitate an easy representation of other hard problems.

**Poster Title:** Rapid Mission-Driven UAVs – Customizable and Trustworthy through COTS and Control Co-Design

**Faculty Mentor(s):** Dr. Taylan G. Topcu, Dr. Andrea L'Afflitto

**Student Researcher(s):** Andrea G, Micaela R, Ethan C, Marc S, Maguire M

**Abstract:** This research focuses on developing a rapid and automated approach to design and assemble customizable unmanned air vehicles (UAVs) using commercial off-the-shelf (COTS) components. Our current work includes creating a UAV component catalog following a basic quadcopter configuration where the necessary specifications were identified and integrated into a database to enable seamless data retrieval and analysis for a performance calculator. The calculator aims to estimate key flight characteristics such as endurance, range, and thrust-to-weight ratio. Moreover, simplified CAD models of individual drone components have been created, with joint points identified to ease automated assembly through Python scripts. Future work involves refining the performance calculator and CAD assembly processes to generate optimized UAV configurations tailored to user-defined mission requirements.

**Poster Title:** Resilience of AI-Enabled Systems using FAIREST Principals

**Sponsored by:** Office of the Under Secretary of Defense for Research and Engineering (OUSD R&E)

**Faculty Mentor(s):** Dr. Tyler Cody, Mary Nerayo

**Student Researcher(s):** Danielle K, Rishika B, Jessica L

**Abstract:** Artificial intelligence is increasingly used in mission-critical systems, including autonomous cyber defense. However, AI components are vulnerable to novel attacks and performance degradation that traditional resilience approaches cannot fully address. This project applies the FAIREST framework—Framework for Artificial Intelligence Resilience in Engineering and System Test—to study and model AI resilience in a DARPA Cyber Grand Challenge-inspired scenario. Using model-based systems engineering (MBSE) and STPA-inspired hazard analysis, we map system behavior, identify failure paths, and evaluate recovery strategies. Our goal is to demonstrate how FAIREST enables the design and testing of robust AI systems through structured modeling, simulation, and detection-mitigation-recovery mechanisms.

## Poster Abstracts

**Poster Title:** RTX Autonomous Vehicle Competition

**Sponsored by:** RTX (RTX Fellowship program)

**Faculty Mentor(s):** Dr. Kevin Schroeder, Dr. Scott Kennedy

**Student Researcher(s):** Max A, Shray G, Nicholas H, Sneha M, Sreeaditya M, Ella R, Andrew V, Gregory W

**Abstract:** This competition provides students the opportunity to solve real-world problems by using their creativity, innovation, and team communication skills to research, develop, integrate, and test two unmanned vehicle systems. One system (the Scout vehicle) must search for a predetermined delivery location signified by an ArUco marker, and the other system (the Delivery vehicle) must carry a package to that delivery location. Students compete against teams from other universities and are judged on accuracy and time taken to deliver the payload.

**Poster Title:** Russia's Use of Gendered Disinformation As a Tool of Hybrid Warfare Against the United States

**Faculty Mentor(s):** Dr. Trevor Wilson

**Student Researcher(s):** Samantha B, Nicole E

**Abstract:** This study aims to examine how gendered disinformation functions as a form of soft power in Russia's broader geopolitical strategy. By framing gender equality and LGBTQ+ rights as existential threats to "traditional values," Russian state and non-state actors manipulate public discourse to weaken trust in democratic institutions and fuel polarization in the U.S. and allied nations. This analysis details how gendered disinformation serves as a form of hybrid warfare, ways gendered disinformation is spread throughout the U.S., as well as Russia's political motivations and strategic purpose.

**Poster Title:** SCVI: Bridging Social & Cyber Dimensions

**Sponsored by:** VICEROY

**Faculty Mentor(s):** William Hanley

**Student Researcher(s):** Shutonu M, Thomas N, Hyungmin K, Chen-Wei C

**Abstract:** The rise of cyber threats on social media platforms necessitates advanced metrics to assess and mitigate social cyber vulnerabilities. This paper presents the Social Cyber Vulnerability Index (SCVI), a novel framework integrating individual level factors (e.g., awareness, behavioral traits, psychological attributes) and attack-level characteristics (e.g., frequency, consequence, sophistication) for comprehensive socio-cyber vulnerability assessment. SCVI is validated using survey data (iPoll) and textual data (Reddit scam reports), demonstrating adaptability across modalities while revealing demographic disparities and regional vulnerabilities. Comparative analyses with the Common Vulnerability Scoring System (CVSS) and the Social Vulnerability Index (SVI) show SCVI's superior ability to capture nuanced socio-technical risks. Monte Carlo based weight variability analysis confirms SCVI's robustness and highlights its utility in identifying high-risk groups. By addressing gaps in traditional metrics, SCVI offers actionable insights for policymakers and practitioners, advancing inclusive strategies to mitigate emerging threats such as AI powered phishing and deepfake scams.

**Poster Title:** Securing the Pacific: U.S. Strategies to Counter China and Strengthen Disaster Resilience in the Pacific Island Countries

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Paris A, Abigail B, Lily B, Alex D, Nicole E, Zoe F, Jack F, Kelsey G, Parker G, Michael G, Ben H, Shannon H, Alden K, Fiona W, Franziska W

**Abstract:** The current project outlines a dual track U.S. approach on engagement with the Pacific Island Countries (PICs) in the context of the growing influence of China. This will include a broad range of diplomatic and economic measures-including trade agreements, debt-for-nature swaps, and education programs for youth-as well as measures focused on climate adaptation in terms of projects such as community-led relocation, disaster preparedness, and ecosystem-based adaptation. It will make an effort to create sustainable and culturally attuned alternatives to interventions by way of loans from China. By strengthening regional partnerships, increasing U.S. presence, and supporting local resilience, the United States may restore trust and counter China's reach and thus promote long-term stability across the Pacific.

**Poster Title:** Spectral Warrior | Learning RF through Gamification

**Sponsored by:** Naval Surface Warfare Center - Dahlgren Division

**Faculty Mentor(s):** Dr. Chris Headley, Dr. Brad Davis, Elliott Rheault

**Student Researcher(s):** Hannah B, Clarence B, Brianna D, Madeline D, Kaden E, Laura J, Jayden K, Espen L, Tobechi O, Casie P, Dillon R, Aditi S, Isaac T, Aditi S.

**Abstract:** Through the virtual reality Spectral Warrior concept, we aim to provide a thorough and detailed learning experience of radio frequency concepts. The player will learn antenna propagation and beamforming concepts and apply what they've learned to jam enemy missiles and protect the integrity of their ship. Through the gamification of radio frequency concepts, we hope to offer a realistic and immersive educational resource for students and workforce training to our sponsor, NSWC Dahlgren.

**Poster Title:** Strategic Operations Center (SOC): Threat Intelligence for Adversary & Host Attribution

**Faculty Mentor(s):** Flex Vaughn

**Student Researcher(s):** Marlyn N, Connor B, Miles Z

**Abstract:** This paper introduces an argumentation-based framework for cyber-attribution analysis using Defeasible Logic Programming (DeLP). The proposed model leverages formal reasoning to construct and evaluate arguments for identifying attackers in situations involving contradictory evidence. Unlike traditional methods that struggle with deception—where multiple adversaries may be linked to a single attribute—this approach effectively filters out misleading information. Utilizing data from a DEFCON Capture-the-Flag event as a realistic simulation of cyber attacks, the framework demonstrates enhanced accuracy in pinpointing adversaries. The results suggest that integrating DeLP with practical event data offers a promising strategy for advancing cyber-attribution technologies and improving the overall reliability of attacker identification.

## Poster Abstracts

**Poster Title:** Subnational Diplomacy: Purpose, Models, and Implementation

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Jason B, Lindsay L, Colten R, Camila B, Matthew C, Rachael C, Mya K, Martin O, Reina R, Ardenne S

**Abstract:** This poster presentation will focus on subnational diplomacy as an underutilized and invaluable method of foreign policy. Through the development of a practical framework that aims to answer the question, "How can cities and states conduct international relations?" We conclude that subnational entities such as cities and states are actively conducting international relations and subnational diplomacy should be increased. This decentralized form of engagement must remain under the umbrella of American foreign policy doctrine, something subnational entities have not always reflected. Cities and states are conducting international relations currently; however, there is a danger within this decentralized foreign policy, as entities can conduct diplomacy outside of the ideals of American security doctrine. To solve this national security risk posed by subnational diplomacy, there must be an established criteria methodology for all subnational entities wishing to take part in international engagement, and the benefits they bring.

Our project has sought to establish what subnational diplomacy is, how it is currently conducted between the United States and actors abroad, outline the proposed national security risks of conducting subnational diplomacy without federal oversight, and alleviate these concerns by establishing a methodology for how to conduct subnational diplomacy.

**Poster Title:** Thirty Years After Normalization: A Celebration of the U.S.-Vietnam Relationship

**Sponsored by:** U.S. Department of State Diplomacy Lab

**Faculty Mentor(s):** Robert Hodges

**Student Researcher(s):** Maysem A, Olivia B, Carter E, Zoe G, Morgan H, Amy H, Maddy I, Ajax L, Brian L, Lucia M, Seth M, Kiley M, Sophia R, Kate T, Madigan V, Will C, Mahima S

**Abstract:** Virginia Tech, in collaboration with the U.S. Department of State, is developing a comprehensive resource highlighting key milestones in U.S.-Vietnam relations. As part of this initiative, the team is also designing an educational curriculum aimed at fostering mutual understanding between students from both nations. This curriculum presents the Vietnam War through a positive lens, emphasizing reconciliation efforts and progress achieved through bilateral cooperation.

**Poster Title:** Uncertainty Quantification Framework for Digital Twins

**Sponsored by:** Leidos

**Faculty Mentor(s):** Dr. Justin Kauffman

**Student Researcher(s):** Brandon F

**Abstract:** We are developing an uncertainty quantification (UQ) framework to wrap around the models necessary for developing the digital component of a digital twin. The concept of a digital twin can enable rapid design decisions early in the product life cycle, while also assisting in decision-making, in real-time, during mission execution. A key component of a digital twin is the incorporation and assessment of uncertainties from the models that compose the digital twin. Uncertainty quantification needs to occur throughout the entire modeling pipeline and assist with determining what tests to perform throughout the design cycle, focusing on areas in the operational envelope that have high uncertainty. Our framework will develop an uncertainty map within the operational space and mark locations in the space that corresponded to test results. Ultimately, this uncertainty map can then undergo a transformation to describe levels of risk that should be explored in future test campaigns. To begin this effort, we will focus on surrogate systems where we are able to emulate test data to reduce the need for a current physical twin.

**Poster Title:** Use and Abuse - Analyzing Political Emails

**Sponsored by:** RTX (RTX Fellowship Program)

**Faculty Mentor(s):** Dr. Alan Michaels, Jared Byers

**Student Researcher(s):** Daniel H, Alexis H, Aditya K

**Abstract:** In the Use and Abuse project, we have employed active open-source intelligence (OSINT) techniques to test the question of how our personal information is used, shared, or otherwise abused. To do this, we created an automated collection framework with realistic fake identities used in one-time online transactions and then passively collect email, voicemail, and SMS responses from that event. The key highlights are the results from over 2,000 fake identities that were used to sign up for the declared political candidates in the 2024 U.S. Presidential, House, and Senate elections, tracking how the information was used or shared. Additional trends are demonstrated for attempting to predict the outcomes of races based upon their messaging behaviors, coordinated intra-party responses to events, the post-election and post-inauguration phases, the lack of direct mailings, and other anecdotes. The focus is about the data/trends and what our expectations should be for our personal privacy when providing our information to political candidates.

**Poster Title:** Using AI for Software Test Generation

**Sponsored by:** Senior Military College Cyber Institute

**Faculty Mentor(s):** Dr. Mark Thompson

**Student Researcher(s):** Wesley F, Sam P, Qais S

**Abstract:** As the cybersecurity landscape evolves and AI-powered attacks become smarter, we embrace AI in our security testing processes to create more secure, resilient systems that are better equipped to withstand the ever-changing threat landscape. Traditional methods often fall short due to their reliance on manual processes and limited scope of analysis. By analyzing code and learning from past vulnerabilities, AI can generate smarter, more effective test inputs to produce test cases that humans might miss. This work explores artificial intelligence and machine learning algorithms to analyze vulnerabilities in software and in unmanned aircraft, or drones, and then automatically generate test cases that exercise each system in a comprehensive and effective manner. We expect our results to show that AI can be used to automate and assist in the process of security testing, resulting in improved test case coverage areas.

## Poster Abstracts

**Poster Title:** Using Intelligent Conversational Agents to Empower Adolescents to be Resilient Against Cybergrooming

**Sponsored by:** Griffiss Institute

**Faculty Mentor(s):** Dr. Jin Hee Cho, William Hanley

**Student Researcher(s):** Arav S

**Abstract:** Cybergrooming is a significant online threat, and with increasing digitization, we focused on an AI-based solution to counter these risks. This research presents an adaptive chatbot designed to help minors recognize and resist cybergrooming through realistic, data-driven interactions. The system uses a large language model fine-tuned on an annotated Perverted-Justice (PJ) dataset, where conversations were segmented and tagged using GPT-4 and Claude to enhance detection accuracy. A hierarchical deep reinforcement learning framework enables dynamic responses, with a central policy guiding conversation flow and six sub-policies refining interactions based on user sentiment and behavioral patterns. Simulated interactions assess the chatbot's effectiveness before deployment. Ultimately, this work advances AI-driven online safety by equipping minors with a tool to better understand and resist cybergrooming tactics.

**Poster Title:** Utilizing OSINT to Identify Russian High-Value Targets

**Sponsored by:** National Intelligence University

**Faculty Mentor(s):** Dr. Mayur Gosai (NIU), Colleen Bartos

**Student Researcher(s):** Patrick L, Logan K, Cameron U, Dori V

**Abstract:** This independent research project was conducted by students with the objective of identifying and locating military sites vital to Russia's operations in Ukraine. Since June 2024, this project's analysts have utilized different open-source intelligence (OSINT) resources, observing which military sites the Russian Armed Forces consistently used for operations in Ukraine. By manually entering data onto a map using different geographic information system softwares, this project team created an interactive map of Russia's military sites across the Federation.

**Poster Title:** VT UTProSat-1 and HERMES: a Satellite Surrogate Communication Testbed for Ground-Station validation using Software Defined Radio and OpenC3 COSMOS

**Faculty Mentor(s):** Gustavo Gargioni

**Student Researcher(s):** Luiz B

**Abstract:** This poster details the design, verification, and validation (V&V) of the Hardware Electronic Real-time Message Exchange System (HERMES), a satellite surrogate communication testbed (SSCT). HERMES leverages commercial off-the-shelf (COTS) hardware to emulate a deployed satellite communication subsystem. The system comprises a small and low-cost ground-station (GS) setup testbed for evaluating the data-link communication between the satellite and GS. HERMES weighs the capable open-source ground-station user interface OpenC3 COSMOS for sending packets while offering a firmware for emulating the responses from the satellite flight computer. The hardware is built on top of Raspberry Pi controllers with software-defined radios (SDRs) communicating with each other. HERMES was also designed to communicate with a satellite's communication subsystem directly.

To test the HERMES testbed capabilities, it was used to simulate communication with Virginia Tech's Ut Prosat-1, a 3U cubesat mission slated to launch in 2025. Multiple tests were conducted using a standard communication protocol to emulate uplink commands and downlink telemetry packets being sent to and from the GS. Future testing will include direct communication with an engineering model of Ut Prosat-1, also simulating Doppler shift correction.

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