UF Fall 2024 I4D Projects

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USAF Eglin AFB – Software Enabled Weapon

The Air Force Research Laboratory Munitions Directorate (AFRL/RW) is building an app-enabled innovative model-based and modular software pipeline for flight systems coupled with powerful AI-driven decision-making engines to radically accelerate the flight system's performance update cycle. As part of that development, we seek to create hardware agnostic weapon-centric modular and re-usable apps that can be tailored for diverse missions and platforms via configuration, avoiding hardware modifications. The purpose of this project is to develop or leverage recent advances in AI to provide a capability to flight systems of combining knowledge of prior operational data with real-time data to drive decisions and to rapidly update parameters/plays/strategies of flight systems over-the-air to maximize performance.

Potential Solution

An ideal solution would provide an algorithm or approach to enable consistent model and strategy updates based on prior and real-time. This solution may entail AI-enabled predictive models paired with generative capabilities such as large language models.

Ideal End State

Proof of concept demonstration using an AI-driven solution. The demonstration could be shown through a simulation, relevant hardware, or a relevant or analogous software environment.

Suggested Majors

AI/Machine Learning, Computer Modeling/Simulation, Computer Science, Data Analysis/Visualization, Software Development, (potential) Hardware/Electrical Engineer

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USAF Eglin AFB - Base Integrated Mesh Management System

The USAF 96th Test Wing stationed at Eglin AFB is interested in developing a novel Base Integrated Mesh Management System (BIMMS) to ensure secure and safe operations on the nation's largest base. Currently, there is no system or low-cost method that can effectively and efficiently monitor and report the status information for the 724+ square miles comprising Eglin AFB and its land-based ranges. The purpose of this project will be to develop a user customizable interface that can display/calculate data from a secure long-range mesh sensor system covering a multitude of applications, built in-house for Eglin users. The hardware system will be purpose built with wide integration capabilities while providing the confidentiality required for OPSEC.

Potential projects from which one application will be selected include:

- Gate ID verification & entry system: Develop a "fast pass" gate for access to the military installation using an identification scanner and facial recognition that when authenticated, activates/raises/removes a barrier arm to allow the visitor to pass.

- Detecting cars/people/animals in closed ranges, lost hikers, open/closed gates: Develop a system that senses/detects cars/people/animals in closed ranges, assesses the data for threat/risk, alerts security personnel with assessed data and recommended courses of action, and potentially deploy manned and/or unmanned systems for interrogation.

Potential Solution

Utilizing commercial off-the-shelf sensor nodes and a custom-built graphical user interface, the project aims to provide users a culmination of sensor-based information to provide actionable insights.

Ideal End State

Field testable prototype within a year

Suggested Majors

AI/Machine Learning, Communication and Networking Technologies, Computer Science, Cybersecurity, Data Analysis/Visualization, Software Development

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US Southern Command - DRAMOC Normalization Roadmap for Uncrewed Autonomous Systems

Policy refinements need to be strategically aligned to technology investments to accelerate the societal, economic, and national benefits that can come with autonomy.

The Department of Defense (DoD) and the Federal Aviation Administration (FAA) are investing heavily to normalize employment of autonomous systems and realize the benefits seen in overseas conflicts, humanitarian efforts, and commerce. The US Southern Command (SOUTHCOM) in support of the DoD Defense Modernization Strategy serves as an innovation hub where uncrewed autonomous systems (UAS) are used in operations and R&D evaluations. Technology's evolving ability to self-navigate/redirect, artificial intelligence/machine learning (AI/ML) compute on the edge, and swarm at distances and quantities have outpaced both policy and onboard sense-and-avoid advancements needed to satisfy DRAMOC (due regard alternate means of compliance) approval processes quickly and efficiently.

Both US Military and Industry need a means of closing the chasm between DRAMOC policies and UAS technology limitations that is predictably and situationally adaptable to use-cases supporting military modernization and economic growth. Neither indiscriminate acquiescence of policy protecting safety of life, nor insistence on universal unfailing sense and avoid technology satisfies this problem. However, a reasonable progression of each might, and so there are two interdependent problem statements here: 1) policy modernization, and 2) technology advancement.

Potential Solution

Close the DRAMOC chasm between policy and technology realities in a world of autonomous needs. An ideal solution would provide an attainable vignette-based technology-policy roadmap

for accelerating onboard sense-and-avoid and normalizing DRAMOC standards to reach (with technology advances) predetermined approved UAS DRAMOC acceptance(s) by vignette (use-case). This roadmap will enable policy and DRAMOC officials to authorize general use-case approvals to technology developers and organizations in anticipation of and as incentive to advance the on-board sense and avoid enhancements needed to satisfy the vignettes (use-cases) envisioned for commerce, humanitarian, and military advancement. This roadmap will predictively set milestones and thresholds for expanding UAS employment that balances the potential isolated risks of autonomous flight with the predictable broad negative impacts of failing to advance autonomous flight.

Ideal End State

The roadmap technical validity and recommended policy-guidance refinement will be accepted in principle by controlling stakeholders so opportune technical advancements receive investment funding knowing that DRAMOC officials and oversight will (with high probability) permit rapid employment of advancing autonomous systems that adhere to the roadmap vignettes.

Suggested Majors

Aviation/aerospace, Robotics/autonomy, Systems Engineering, Sensor Sciences, AI/Machine Learning, Hardware/Electrical Engineer, Economics and Policy (related to DRAMOC and/or emerging technologies)

US Central Command - Autonomous Prime

US Central Command (CENTCOM) air, ground, and maritime military personnel need the ability to orchestrate communication of several disparate autonomous systems capabilities used in land, sea, and air domains to reduce the risk of human error during operations and increase efficiency and effectiveness of systems through cooperation and shared situational awareness.

There is a noticeable increase in the presence of autonomous vehicles across various levels of autonomy. The Secretary of Defense (SECDEF) replicator initiative aims to rapidly deploy hundreds or even thousands of critical autonomous systems in land, sea, and air domains.

Human interaction is envisioned to collaborate with autonomous vehicles in theory. However, there exists a challenge in programming these vehicles due to their usage of different software systems that often operate independently without seamless integration, unlike a network of interconnected sensors and vehicles. Presently, the focus lies on individually deploying autonomous vehicles without considering their collaborative potential. To achieve more significant tasks, it's imperative that these vehicles can work collectively.

Autonomous vehicles are currently employed for tasks such as exploring and mapping the subsurface of the ocean, enhancing situational awareness by mapping the Earth's surface, and capturing images. There is also a prevalent use of autonomous vehicles designed for destructive purposes, such as one-way drones equipped with warheads, reflecting a broader trend in the utilization of these technologies.

However, there seems to be a lack of proactive effort at this stage to find comprehensive solutions. The military, for instance, acquires autonomous systems without a unified approach to ensure inter-system compatibility and simultaneous operation.

Efficient communication and data transfer between autonomous systems, even in scenarios like underwater operations, pose significant challenges. Automation in the context of these vehicles involves not only their autonomy but also the seamless exchange of data and communication between different systems.

Potential Solution

There is a need for automation tools that reduce the dependence on human intervention for validation, enabling autonomous systems to operate more independently.

Desirable capabilities involve having a fleet of autonomously functioning systems capable of queuing each other based on predefined triggers in a predefined manner. A universal plug-in tool could facilitate seamless integration among these disparate autonomous systems.

Ideal End State

If this problem was solved it would result in providing warfighters with enhanced capabilities to effectively respond to threats. Even within industry, various autonomous systems lack integration and standardization, presenting similar challenges to those encountered in other domains. Potential beneficiaries include Autonomous Industries, Firefighters, Navigation Systems, and Transportation Systems.

Suggested Majors/Skills

Autonomy, Coding, Communication, Data Analytics and Visualization

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US Army - Unified Data Reference Architecture (UDRA)

The UDRA is to transition the Army from its current Network/System centric data architecture to become a Data-Centric Force. Faster on-Demand data delivery to decision-makers will enable accelerated mission execution and success. To solve this the Army is introducing the UDRA which introduces data mesh principles to flatten and simplify the Army's data architecture, streamline data product sharing across mission partners, and support data-driven decision making at greater speed and scale. The purpose of this effort, is to prototype the UDRA to draft recommendations, ranked by importance and categorized as appropriate and give PEO STRI feedback in shaping the UDRA data products, services, and environments.

Potential Solution

An ideal solution would provide an approach to prototyping, potential services, and data products to develop a data mesh following UDRA specifications. This solution can also include end-to-end real world use cases for PEO STRI/Army.

Ideal End State

Working prototype showing full cycle of data tagging, data storage, data discovery and data download. The demonstration should be shown in a relevant software environment.

Suggested Majors

Computer Modeling/Simulation, Computer Science, Data Analysis/Visualization, Software Development, Industrial and Systems Engineering, Data Scientist