Raytheon UAS Showcase

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Executive Summary

Raytheon Technologies, a prominent defense and aerospace company, hosts the **Unmanned Aircraft Systems (UAS) University Innovation Showcase** annually to drive innovation in the UAS field and solve real-world problems.

The competition invites teams from universities to develop, implement, and test hardware and software components for designing a UAS that can accomplish specific tasks.

The University of Texas at Arlington (UTA) has put together a large team comprising **Electrical**, **Mechanical**, and **Computer Science Engineering** seniors who will collaborate on an unmanned aerial vehicle (UAV) and unmanned ground vehicle (UGV) to participate in the competition.

This project aims to promote the integration of multiple engineering disciplines to develop cutting-edge UAS technology to address real-world challenges.

Background

This project is being undertaken in response to the growing demand for unmanned aircraft systems. As drones' capabilities increase, they are used in a variety of applications, such as military operations, monitoring, surveillance, and recreation. Under the mentorship of Christopher McMurrough, the student computer science team will develop a drone that will demonstrate the capability of firing a laser at moving ground targets encountered during autonomous flight. By researching and developing software that allows for the full autonomy of airborne drones, the student CSE team will address the rapidly growing demand for autonomous aircraft systems. Coordination with electrical and mechanical engineering students will be a key aspect of the development process. In addition to gaining a comprehensive understanding of drone technology throughout the project, students will be able to apply this research in various areas, such as disaster relief, land surveying, law enforcement, and military applications.

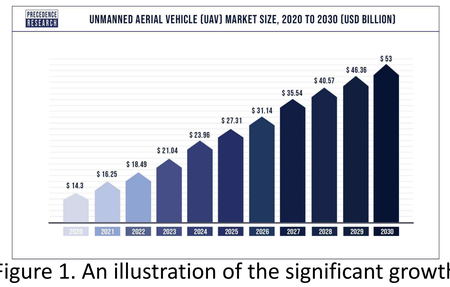
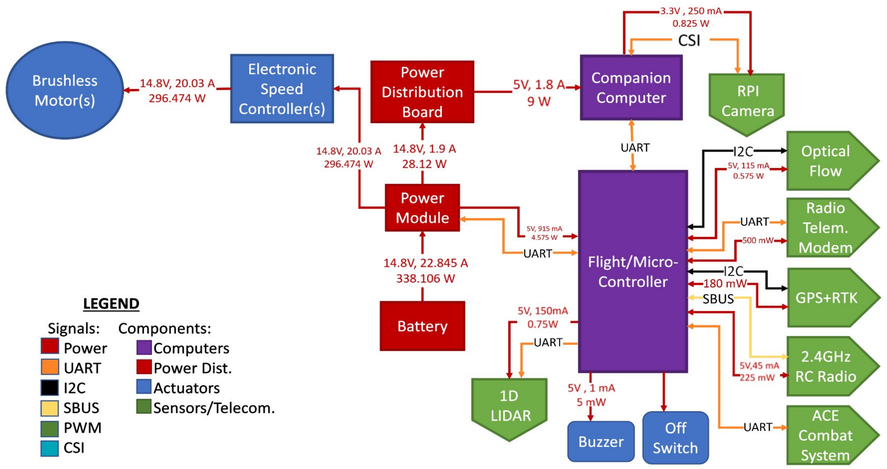


Figure 1. An illustration of the significant growth projections of the unmanned aerial vehicle market

Experimental Setup

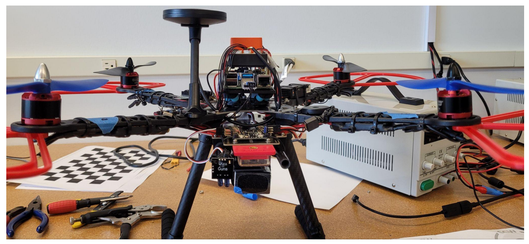
The main unmanned aerial vehicle (UAV) components are comprised of a Cube Orange flight controller, Pi Camera, ACE Combat System, motors, and the navigation system, which collectively function to facilitate autonomous missions. The block diagram provided below offers a visual representation of these essential components:



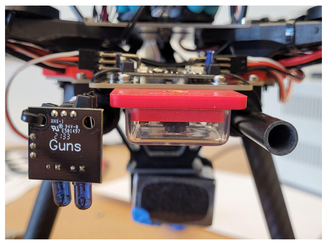
Overview

The unmanned aerial vehicle (UAV) is equipped with the capacity to function autonomously, which enables it to execute takeoff and landing procedures, as well as navigate designated flight paths without requiring direct human intervention. The UAV is designed to detect and engage hostile unmanned ground vehicles (UGVs) that possess ArUco markers affixed to their frames during flight. This is achieved by utilizing the OpenCV platform, which facilitates the identification of hostile markers, and the ACE Combat System, which is integrated with an LED laser that is deployed to engage the identified targets.

Throughout the UAVs flight, it deploys a dual Internet Relay Chat (IRC) bot system that supports efficient communication and information-sharing. Once the laser is fired at a UGV, the UAVs primary IRC bot instantly relays a notification to the IRC server, which contains crucial details regarding the target UGV. To verify if the UGV has been successfully hit, the system meticulously inspects the IRC messages emanating from the affected UGV, which are continuously received by the UGV_HitListener, a secondary IRC bot that operates separately. It is noteworthy that the UAVs combat functionality is exclusively reserved for engaging hostile targets, as it ceases all combat activities upon encountering friendly markers.



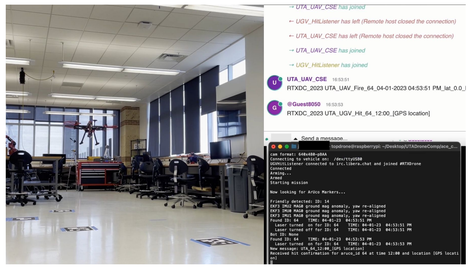
Test Drone Design



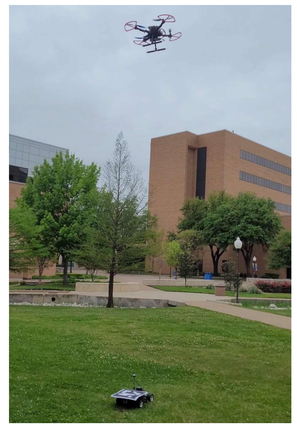
Pi Camera And ACE Combat System

Testing

The CSE team tested the UAVs manual flight capabilities before moving on to autonomous flight testing with the Pi Camera. ArUco marker detection was refined by examining camera footage while holding the UAV directly above the markers. Long ribbon cables caused distortion, which was fixed by installing shorter cables. Verification of ArUco detection was followed by successful manual flights with multiple markers on the ground. The team then tested the ACE Combat System and LED laser, integrated the IRC bots, and conducted autonomous flight tests with the unmanned ground vehicle to address any issues.



Manual Flight Test Being Conducted



Autonomous Test vs UGV

Conclusions

The CSE team conducted comprehensive testing to evaluate the UAVs capacity to perform tasks in compliance with Raytheon's specifications. The UAV demonstrated exceptional proficiency in meeting the specified requirements, albeit some limitations were identified. Notably, the IRC feedback loop experienced occasional failures in detecting hits on UGVs not directly below the laser, leading to an inconsistent confirmation of UGV hits. Additionally, there were issues with UGVs not sending hit messages to the IRC server correctly or at all. The GPS accuracy levels were suboptimal, but the UAV successfully navigated designated flight paths with sufficient accuracy.

In appreciation of the opportunity to work on this project, the CSE team would like to thank Raytheon, Raytheon Sponsors, and the University of Texas at Arlington. The team has been given an amazing opportunity to collaborate with an industry leader and bring new ideas and innovations to the table. The team is excited to use this experience as a launching pad to further research and development efforts. The team is grateful for the trust and confidence that Raytheon and our sponsor have placed in the entire UTA student team, and will continue to make the most of this opportunity. The team looks forward to a productive and successful outcome.

References

Figure 1. "Unmanned Aerial Vehicle (UAV) Market (by Class: Tactical Uavs, Small Uavs, and Strategic Uavs; by Technology: Fully-Autonomous, Semi-Autonomous, and Remotely Operated; by System: UAV Payloads, UAV Airframe, UAV Avionics, UAV Software, and UAV Propulsion; by Application: Commercial, Military, and Recreational) - Global Industry Analysis, Size, Share, Growth, Trends Analysis, Regional Outlook and Forecasts, 2021 - 2030." *Precedence Research*, Precedence Research, 2021, https://www.precedenceresearch.com/unmanned-aerial-vehicle-market.