Thesis Project Portfolio

The Development of an Autonomous Multirotor Drone in Conjunction with OptiTrack

(Technical Report)

Autonomous Drone Impact on the 2023 Israel-Hamas Conflict

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2024

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Sociotechnical Synthesis

My technical project was to create an autonomous multi-rotor drone to be flown in the Reactor Room at the University of Virginia's (UVA) old nuclear reactor site. The Reactor Room is a circular room with a ceiling around 10 meters high. This room is the home of multiple projects, including the autonomous multirotor drone project. There is a net cage located near the entrance of the Reactor Room to account for safety when the drone is flying. A motion capture system, OptiTrack, consists of 16 cameras placed at even intervals around the top of the room and was installed in order to conduct drone research. OptiTrack provides high-precision 3D positional data, which allows for mission planning and high-level object avoidance when paired with hardware onboard drones flying in the space. The data gathered from OptiTrack, such as velocity, acceleration, rotation and orientation, marker trajectory, and more are able to be exported to software such as MatLab for further analyzation. In order for the system to pick up on drones flying in the Reactor Room, they must have at least three reflective markers placed in visible locations around the drone.

To begin this technical project, my group constructed a quadcopter drone with autonomous capabilities through Raspberry Pi and PixHawk using ArduPilot. Manual outdoor flight was successful with a few autonomous features such as stabilize, loiter, and return to home. These three simple autonomous features were programmed into the remote controller we were using and were activated by a single switch. ArduPilot autonomy was achieved outdoors with two waypoints tested. Indoor manual flight was achieved, but indoor autonomy was not attained this year. The Raspberry Pi onboard the drone has "connect and arm" as well as "take off and land" scripts ready to be tested. Once these are tested, a closed-loop connection should be established between the Raspberry Pi and OptiTrack in order to use OptiTrack for autonomy.

My STS project was on autonomous drone impact on the 2023 Israel-Hamas conflict. I delved into a short history of Israel and Hamas's conflicts beginning when Hamas was elected to the Palestinian Legislation Council and overtook their government. I then went into the difference between military and recreational drones and how they are used by both Israel and Hamas in this conflict. Hamas has been using Da Jiang Innovation (DJI) drones to attack Israel, which is a tactic farmed from Russian drone attacks on Ukraine. DJI is a company specializing in recreational drones for use by civilians and researchers only. They forbid the use of their drones for military purposes and cease all ties with any distributors who sell to militarists or groups with the intent of using DJI drones for harm. This paper delves into how the accessibility of autonomy and high-level technology assists in destruction and more violent warfare. Public policies regarding drone usage, both civilian and military, are studied and conclusions are drawn on whether these policies are strong enough.

Programmer and developer influence is also studied in this paper. Israel is backed by the United States in this conflict. Therefore, Israel has access to more technologically advanced, militarized drones than Hamas. Hamas seems to choose more primitive means of warfare, as seen by their usage of civilian drones with bombs strapped to them as suicide drones. The United States has their Reaper drones circling the skies of Gaza, and Israel has Elbit Systems drones in their personal arsenal. Elbit Systems is an Israeli company, and this begs the question of how much influence the Israeli government has on the programming of Elbit Systems' drones. There seems to be a very interconnected and complicated web of influence around autonomous drones, war, and country or governmental alliances. Secrecy surrounding these issues and the power behind it all is easily overlooked and blamed on war itself, but it is important to stay vigilant and try to uncover the mysteries of war and war policies.