Thesis Project Portfolio

The Development of an Autonomous Multirotor Drone in Conjunction with OptiTrack

Analyzation of Autonomous Aerial Vehicles and Computational Method Analysis

An Undergraduate Thesis

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Table of Contents

Executive Summary

The rapid growth of technology modules and generative AI application offers an exciting future. While that may be exciting for users who are deeply intrigued by new iPhone models and Samsung TV's, the future is lurking right beneath us: Drone Technology. From delivering medical supplies to inaccessible regions to acting as a security advancement system, unmanned aerial vehicles are a top tier entity with a multitude of applications. My technical research report will focus on the development of a fully autonomous drone with optimized sensor efficiencies. By creating a product from scratch and modifying it for targeted specifications allows us to understand the capabilities firsthand. The drone is not only a medium for research, but rather a creation to understand how they can act effectively. In comparison, my STS report highlights the different influences drones can have in society from a security and privacy perspective. I also delve into the realm of drone assistance and the benefits corrected regulations can provide. By conducting relevant experiments with flight paths and maximized potential, the capability of a drone can be studied. This will allow me to gain experience with the very product I analyze in my STS report and voice a nuanced perspective.

The main issue at hand when analyzing drones is the security and privacy violation concerns. With international airspace being free to fly in and regulations having weak limits on extent of use, the creation of a drone model would allow testing for capabilities. By creating a drone model reliant on a variety of navigation systems such as GPS, Optical Flow, Opti-Track and Raspberry Pi, flight modes are tested to see how precise waypoint detection is. The problem in society is that commercial products such as drones have a large potential to cause chaos, but to what extent do drones advance? The goal of developing a multirotor system that incorporates LiDaR sensors, autonomous flight and advanced mission planners is to understand how creative

the product can be and what kinds of missions are applicable. Methodologically, the project involves test phases, prototypes, additional modifications, and parameter shifts on Ardupilot to match designated flight paths. Each time a new step is taken, the drone's stability and functionality must be judged to assure progress is not lost. Overall, the goal is to create a system that integrates autonomy and showcases potential results on different missions.

The development had a very intricate process which required attention to the smallest details. After assembling the multirotor drone and calibrating, the system was reliant on being manually connected to the mission planner and microcontroller. While connecting the drone to ArduPilot, a mission planning platform, the drone was first tested with manual control and had been stable. After stages of normal testing, the drone was connected to ArduPilot with a GPS connection and then assigned a script to complete a flight path. The drone had successfully completed the path by locating each waypoint and following height parameters. Although the system meets target specification in GPS autonomous flight, the primary connection with Opti-Track is not fully stabilized. When creating a 3D rigid body in the Opti-Track software, motion detection was inaccurate and had a system malfunction. Instead of tracking the body based on motion detected by the cameras in our reactor room, the rigid body was stuck at the center of the plane. Despite Opti-Track requiring future application, autonomous flight was achieved overall and Optical Flow was fully calibrated. The flow sensor was able to attain non-zero values in the data logs, which shows the orientation is complete. To conduct more advanced experiments, Raspberry Pi must be activated fully instead of ArduPilot as the primary mission planner. Lastly, future work requires more attention to optical flow as well to connect the drone fully via PixHawk instead of a wired connection. Overall, the drone was able to utilize

telemetry modules, GPS, and LiDaR camera sensors to effectively fly. The system followed object avoidance and had successful flight experiments.

The STS research report is a pathway that observes the social and ethical implications of drone integration. Despite having its benefits in the economy and effectively eliminating cheap labor, civil liberty is a priority. My paper dives deep into preceding government case studies and research papers about drone technology to accentuate a damaging narrative. Since the general public might have a large variety of uninformed citizens, technology can potentially get by violating rights. Drones were initiated into the military as motion sensors and defense mechanisms, but with their arrival in the commercial market and technology advancing every day, the danger they inhibit is significant. Methodologically, the research employs qualitative analysis and journal reviews which provide accurate insight on the hardware aspect of drones and what they are doing in the world. Whether it involves trespassing of property, exploitation of data breaching, or general physical dangers, the data is all presented to showcase chaos.

After conducting an analysis report, it was clear drone integration can only be seamless with the remodeling of federal regulations and limiting the capabilities of the product in itself. Providing the commercial market with a device that has hacking capabilities, damages property and easily roams around the community grants freedom in directions that violate another human's rights. By incorporating limitations on airspace zones and limiting the potential will assure that drones are under control. The subject of difficulty in this case is who is allowed to buy drones and what is the product being sold for. If intent can never be predicted, it is a better idea to stop a situation before it starts. AI will continually expand and integrate into our society as a whole, but the aftermath must be considered beforehand. The literature review highlighted different political uses of drones and the attack vectors they offer, which further shows their

potential. Drones are a byproduct of their society as Actor-Network Theory and the Social Construction of Technology both promote. The concepts reveal that technology is shaped by the very citizens who have needs and require differing design requirements. Overall, drones need to be regulated more effectively in order to assure the safety of everyday civilians.

By bridging the gap between innovation and ethical consideration, my aim is to relay a nuanced perspective on technology that may not be available to common citizens. Reporting this knowledge not only informs the public but allows academics to understand the severity of the situation.