Thesis Project Portfolio

The Development of an Autonomous Multirotor Drone in Conjunction with OptiTrack

(Technical Report)

The Future of Autonomous Drones in Cities

(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

Luke Fox McNabb

Spring, 2024

Department of Mechanical and Aerospace Engineering

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Executive Summary

The integration of drones into smart cities will create new urban development opportunities in many areas including deliveries and public safety, but raises a new set of critical questions regarding liability, regulation, and societal impact. In Dr. Wang's "Challenges and Opportunities in Lidar Remote Sensing," he highlights the many current shortcomings and opportunities with current lidar (2021). First, normal weather events such as rain, fog, and dust can interfere with the lidar's laser prematurely before the laser could reach a real surface, corrupting the scan. My technical research aimed to improve key sensors and algorithms to improve autonomous drone flight. My STS research drew parallel from uavs to prior liability laws and lawsuits of self-driving cars. The responsibility in drone accidents would shift towards manufacturers, incentivizing them to prioritize safety measures.

The journey towards fully autonomous drones is marked by significant advancements in navigation techniques and obstacle avoidance strategies. Optical flow and lidar represent two primary schools of thought, each with its strengths and limitations. While optical flow excels in relative motion perception and precise maneuvers, lidar offers a comprehensive 3D mapping capability for enhanced environment perception.

My technical report provides a comprehensive overview of the design considerations for creating an autonomous drone. A manually operated drone was constructed last semester, and autonomous functions with mission planning were achieved this semester–first through ArduPilot and in the future, through Raspberry Pi. The incorporation of advanced sensors, computing power, and autonomy features will result in a versatile platform capable of performing a wide range of tasks independently. This semester, we successfully established a secure testing protocol within the reactor room by employing a pulley in order to effectively minimize risks and enhance safety during manual testing procedures. After a few successful outdoor GPS autonomous flights, the next step for this project is to establish a closed loop system connecting the OptiTrack setup within the reactor room with the Raspberry Pi and LiDAR sensors integrated into the drone.

The integration of drones into smart cities raises significant questions regarding liability and regulatory frameworks. My STS research explores the evolving dynamics of responsibility in the context of autonomous drones, drawing parallels with the emergence of self-driving cars to shed light on potential legal and ethical challenges. Through an interdisciplinary approach encompassing law, technology, and sociology, this research investigates the implications of assigning liability to manufacturers versus individuals in scenarios of drone accidents and disruptions. The analysis suggests that while a manufacturer's liability will incentivize companies to prioritize product reliability and safety, certain circumstances such as hacking or sabotage would shift blame again.

In conclusion, as my technical report aimed to do, navigational technologies and algorithms will improve, making drones more prevalent in many cities and industries like shipping and safety. Both companies and individuals will require laws and regulations to govern the use of autonomous drones.