Thesis Project Portfolio

Autonomous Obstacle Avoidance for Unmanned Aerial Vehicles (UAV)

(Technical Report)

Lack of International Consensus Regarding Usability of Lethal Autonomous Weapons Systems (LAWS)

(STS Research Paper)

An Undergraduate Thesis

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

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In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

Sammy Nayhouse

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Sociotechnical Synthesis
(Executive Summary)

Autonomy in Focus: Balancing Ethics and Technology

In my undergraduate thesis portfolio, I present my technical capstone project, involving the development of semi-autonomous drones, and my STS research paper, which investigates the historical impediments to an international consensus surrounding the definition and usability of lethal autonomous weapons systems (LAWS). These projects are connected as they both explore the ethical and technical aspects of autonomy in aerial systems and weaponry. I chose to work on these projects because I wanted to contribute to responsible technological advancements while navigating the complex ethical landscape surrounding autonomous systems. By creating semi-autonomous drones that emphasize human control and accountability, I aimed to address concerns about fully autonomous systems. At the same time, my STS research investigated the historical factors and different viewpoints among major global players that have prevented a unified stance on LAWS. Taking this combined approach helped me better understand the real-world challenges and consequences of autonomous systems, highlighting the importance of including STS perspectives in engineering practice. This integration is crucial for promoting responsible innovation and ensuring that technological advancements are developed and implemented with careful consideration of their ethical, social, and legal implications.

The technical portion of my thesis presents a novel approach to drone autonomy that addresses the challenges associated with fully autonomous unmanned aerial vehicles (UAVs) and human-controlled aerial vehicles. My project investigates and enables shared autonomy, a combination of human-controlled input and onboard autonomy, to maintain safety while ensuring human input for desired actions. My team designed and developed an aerial platform for shared autonomy and obstacle avoidance in UAVs, utilizing a custom-made printed circuit

board (PCB) with 1-D time of flight LIDAR sensors. An embedded Robotic Operating System (ROS) is employed to visualize real-time LIDAR data and simulate obstacle avoidance for UAV systems. This report highlights our innovative approach to shared autonomy, which allows for safer and more efficient drones, distinguishing our project from past work that relied on switching between human-controlled inputs and onboard autonomy. By striking a balance between human intervention and automation, this technical project contributes to the responsible and ethical development of drone technology in various applications, such as aerial photography, infrastructure inspection, surveillance, and search and rescue operations.

In my STS research paper, I examined the historical factors that contributed to the lack of international consensus on the definition and use of LAWS. The paper argued that divergent views among major global players, like the USA, Russia, and China, on delegating life-and-death decisions to machines have hindered the development of a unified international stance on LAWS. The research utilized the Social Construction of Technology framework to explore various perspectives on the ethical and legal implications of using autonomous weapons, as well as the challenges of reaching a consensus that satisfies the interests of all stakeholders. The STS research paper delved into the ethical and political perspectives of the United States, Russia, and China on LAWS, using literature review and discourse analysis to examine major global players' divergent views on delegating life-and-death decisions to machines. By offering insights for stakeholders and emphasizing the importance of ethical guidelines and international collaboration, the paper aimed to facilitate a cooperative environment for addressing the benefits and drawbacks of autonomous weapon systems effectively.

In reflecting upon the value of working on both my technical capstone project and the STS research paper, I realize that this approach provided me with a unique opportunity to gain

insights that would have been difficult to achieve had I pursued these projects separately. By conducting both projects in parallel, I was able to see how the technical development of semi-autonomous drones informed my understanding of the real-world challenges and complexities in the STS research, particularly regarding the ethical and legal implications surrounding autonomous systems. Conversely, my STS research on the historical impediments to an international consensus on lethal autonomous weapons systems (LAWS) broadened my perspective on the importance of human control and accountability in the technical project. This perspective encouraged me to place a stronger emphasis on shared autonomy in the drone development process, ensuring a more ethical approach to the technology. The combined efforts on both projects provided a deeper understanding of the sociotechnical aspects of autonomous systems, promoting a well-rounded perspective. This interdisciplinary approach is vital for engineers as it prepares them to confront and navigate the ethical, social, and legal challenges that accompany the development and implementation of new technologies. By emphasizing the connection between technical and social dimensions, I have gained a deeper appreciation for the importance of responsible innovation in shaping a more sustainable and ethical future.