Thesis Project Portfolio

Self-Correcting Ping Pong Ball Launcher

(Technical Report)

A Utilitarian Ethics Analysis of the Use of the General Atomics MQ-9 Reaper Drone to Kill Iranian Iranian General Qasem Soleimani

(STS Research Paper)

An Undergraduate Thesis

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Sociotechnical Synthesis

The relationship between my technical project and my STS research project lies in the idea of a self-targeting projectile launching system. However, they differ dramatically in scale and purpose. My technical project involves a system to remotely control and strike several pre-defined targets with a ping-pong ball from a distance of several feet away, and my research discusses the ethical questions surrounding the use of attack drones by the United States to remotely control and strike targets from thousands of feet in the air. With this being the case, my technical project was a brief exploration into the design, testing, and construction of a system that can automatically target and launch a projectile while also considering the safety standards necessary. This is complemented by an exploration into the uses and ethics of such a system in its most advanced and powerful state, a military attack drone.

My technical project is a user-controlled ping-pong ball launching mechanism which plays against a human opponent. Both sides aim to shoot balls into 1 of 9 target squares with better accuracy than the opponent. The mechanism uses a combination of a pan/tilt mount controlled by servo motors, a kick solenoid, and a computer user interface as a control mechanism for the in/out system that aims at the targets and launches the ping-pong balls. This system is controlled by a MSP432 microcontroller board communicating with a laptop running a python3-based user interface via the Universal Asynchronous Receiver/Transmitter communication protocol. To automatically provide feedback and adjustments, an image processing module observes the result of the launch. This communicates back to the computer and then to the microcontroller which adjusts programmatically and physically.

My STS research paper takes another remotely controlled projectile system, attack drones, and through the lens of utilitarian ethics analyzes the overall consequences using these

drones has on all parties involved. To do this, I chose the case of the 2020 drone strike carried out on Iranian General Qasem Soleimani by the United States. This case was representative of drone warfare generally in that a high-value terrorist target was eliminated, there were several civilians killed in collateral damage, and the General Atomics MQ-9 Reaper drone was used to remotely deliver the strike from thousands of feet away. Looking at the immediate consequences, resulting consequences, and number of people involved in each, I used the procedure outlined by Jeremy Bentham to create a moral balance sheet in order to assess the ethics of an action. Through this cost-benefit style analysis, I considered the lives directly taken or saved by the strike, the lives indirectly taken or saved by the strike, the political consequences, and the moral circumstances. This process lead to a determination on whether this act of drone warfare was ethical or unethical.

As an engineer going into the defense space, these projects gave me a great amount of insight into possible future considerations I will need to make. My technical project gave me the experience of fully designing a tangible system from scratch that could remotely operate to achieve an objective and the technical and safety standards needed in doing so. My STS project allowed me to analyze one of these technical systems in its largest state and how to consider ethical usage of such a powerful technology. Together, these projects expanded my appreciation for the difficulty of building electronic and mechanical systems and also the difficulty of ensuring these systems contribute to the overall good of the world.