Thesis Project Portfolio

Exploring AprilTag use with Quadrotors

(Technical Report)

Machine Learning and Artificial Intelligence: The World's Panopticon

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Drones, Machine Learning, and Surveillance: An Unlikely Combination

"Even if you're not doing anything wrong, you are being watched and recorded."
Edward Snowden

I originally chose my STS topic, machine learning and artificial intelligence in surveillance and censorship, as I was initially planning to utilize the Computer Science department's extra elective and Capstone Technical Report option in place of Capstone Research. After electing to do robotics research in Spring 2022, my STS and technical topics became two different subjects. The technical topic explores the use of AprilTag fiduciary systems to aid in autonomous quadrotor use. The STS topic relates to engineering practice by underscoring the need for responsible ML/AI use by governments and companies. Engineers tasked with developing and refining such technologies must weigh the sociotechnical ramifications of overuse of the technology in the domain of surveillance.

In my STS topic research, I conveyed the lack of relation between how democratic a nation is to how much it uses ML/AI to infringe upon its citizens. More specifically, I cited examples across the world where there is a documented deterioration of human rights when governments utilize such technologies to aid in public surveillance and censorship. Using the socio-technical frameworks Actor-Network-Theory, techno attitudes, and engineering as experimentation, a nation's use of the technology could be assessed on a new scale to better understand its ramifications. The results—the decomposition of the effects of the technology's ramifications—found similar social impacts of the technology's use by both the US and China. The results are more startling given the greater public liberties the US seems to bestow upon its

citizens. Similar trends between the two nations insinuate that greater introspection about the technology is needed.

The technical topic explored the use of AprilTag fiduciary systems to aid in autonomous quadrotor use. The AprilTag fiduciary system is a system of QR code-like tags that can are detected by robots and autonomous systems. AprilTags can be utilized for various tasks, including but not limited to augmented reality, robotics, and camera calibration. One of its specializations, giving aid to the calculating angle of attack, allows for greater incorporation into robotics applications. Figure 1 depicts six sample AprilTags. These tags can be attached to walls and objects to be detected by a robot's camera. My research encompassed the utilization of this fiduciary system with Robot Operating System (ROS), the middleware running experimental drones and robots. My work resulted in the documentation for the research team to better incorporate the fiduciary system into future graduate-level research projects.

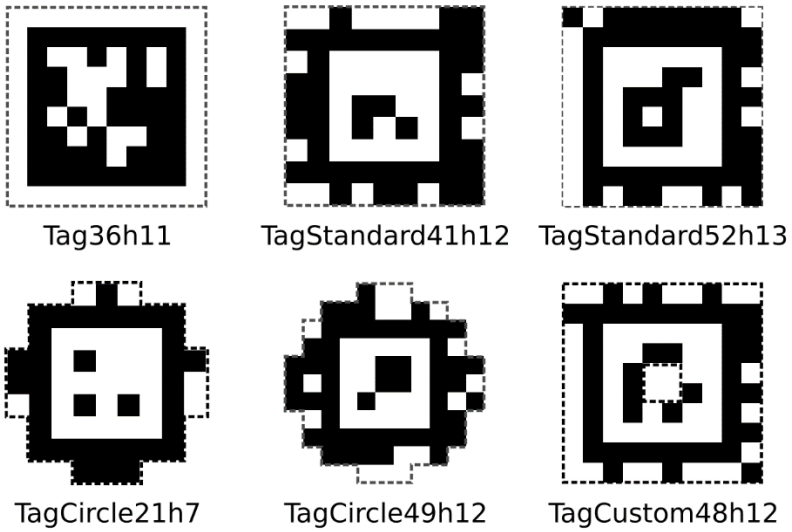

Figure 1: Collection of Sample AprilTags
These six AprilTags depict the simplicity of the tags and close similarities to existing QR code technologies (University of Michigan, n.d.).

My STS topic forced me to see a technology of interest under a new lens; this time criticality. Always in the news, ML/AI have the means to be even more powerful than they

already are. After realizing this potential during my STS research, I have a greater interest in understanding how technology can have disastrous social impacts. From the early mapping assignments in STS 4500 to the Research Paper, I became more aware of my research and writing skills. For example, I employed the “problem mapping” principle from 4500 in my research paper in 4600 by determining the social, technical, and organizational elements at play in my sociotechnical problem. Second, partaking in a research group consisting of only graduate-level students exposed me to technologies otherwise inaccessible (both by cost and expertise) to my peers. During my time with Professor Bezzo, I witnessed the purchase of numerous drones and components worth more than $15,000. The technologies underscored the principles of ethical innovation from STS 4600 and my research paper. Although drone technologies can be easily abused, the team exhibited the utmost regard for building new technologies that can make great impacts on humanity. From attending the Master’s Thesis Defense of a lab mate to the weekly Friday 9:30 AM meetings, the experience I gained will forever stick with me.

Works Cited

University of Michigan. (n.d.). *AprilTag*. April Robotics Laboratory. Retrieved May 1, 2022, from https://april.eecs.umich.edu/software/apriltag#:~:text=AprilTag%20is%20a%20visual%20fiducial,tags%20relative%20to%20the%20camera.