The Development of Self-Driving Vehicle Software via Autonomous Driving Simulators

An Analysis of the Development of Helicopter Egress Training Simulators

A **Thesis Prospectus** Submitted to the

Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree

Bachelor of Science, School of Engineering

Anne Forrest Butler

Fall 2021

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signature anne forrest butler Date May 02 2022

Anne Forrest Butler

Signature Tomonari Date May 02 2022

Tomonari Furukawa, Department of Mechanical and Aerospace Engineering

Signature Richard D. Jacques Date May 02 2022

Richard D. Jacques, Ph.D. Department of Engineering and Society

Introduction

Over the past century, vehicles have become an essential element within our society. Transportation is a key resource that is now needed to successfully work and live within the global network that we've created. Additionally, vehicles such as aircrafts and ships are now utilized not just for transportation, but also by our military for objectives such as the protection of our coastlines and extending humanitarian aid to our allies in crisis. With the development of this reliance on vehicles, comes a need for established training measures to ensure that the operators of these vehicles have the highest levels of proficiency. Without this level of expertise, controlling a car, train, or airplane can become a very dangerous task. A new technology that's emerged in order to provide this integral training within a safe environment is simulators. This new technology is able to replicate the feeling of operating a vehicle, while providing the operator with an environment where they can make mistakes without facing the significant consequences of a real-life experience.[AB1] Additionally, beyond solely training human beings, these simulators are being used to develop new autonomous systems for vehicles. The technology provides the autonomous driving system the ability to enhance its capabilities in a safe environment where it does not face the consequences of real life.

Self-Driving Vehicle Software Development via Autonomous Driving Simulators

The number of car accidents have increased significantly over the past decade, as drivers have become more and more distracted by their cell phones and other devices while behind the wheel. The U.S. Department of Transportation's National Highway Traffic Safety Administration estimates that 8,730 people died in motor vehicle traffic crashes in the first three months of 2021, a 10.5% increase from the 7,900 fatalities the agency projected for the first quarter of 2020

(NHTSA). The central concept behind autonomous driving vehicles is that, by removing a human's control of a vehicle and transferring it over to a computer, the number of driving errors made due to distraction and fatigue will be eliminated, and in turn the number of car accidents will be significantly decreased. However, autonomous vehicle manufacturers such as Tesla, still face a lot of scrutiny regarding accidents that their autonomous vehicles have caused and the potential threat that their systems present to other drivers and pedestrians. By utilizing a simulator, Tesla would be able to eliminate any risk of harm potentially caused by their autonomous vehicles to society during testing. In turn, the cost of testing could be reduced significantly and the societal support they would receive would likely increase significantly. For my capstone project, my group and I are going to be designing an autonomous driving simulator. Our simulator will be able to provide the software system within an autonomous driving vehicle with the training needed to learn and improve its skills, and in turn be prepared to operate on a real road.

In every simulator, there are a set of mechanical input devices that send signals to the operating software in order to generate accurate real-life reactions on the screen or in the motion of the vehicle. These mechanical input devices and the software are linked via sensors, which can measure the input values and then translate those into a value that our software can read and respond to. In turn, the development of an autonomous driving simulator and a modular egress trainer are quite similar. The essential differences lie in the experience that each of the simulators are trying to create.

For my research, I would like to focus on the development of aircraft simulators. Specifically, I will be focusing on a technology that the navy utilizes called an Egress Training Simulator. The simulator allows Navy and Marine Corp helicopter pilots and air crewmen to

experience a simulation of their helicopter crashing into the ocean and in turn practice how to respond to this situation.

An Analysis of the Development of Helicopter Egress Training Simulators

Just this past September, five sailors lost their lives while an MH-60S helicopter was conducting routine flight operations off of the aircraft carrier Abraham Lincoln. The helicopter crashed into the flight deck and then fell into the ocean (Dyer). Although casualties are inevitable when operating complex machinery in treacherous circumstances, the lives of our military members can be protected more efficiently through the continued enhancement of training practices and specifically the training simulators utilized.

In my research, I'm going to be analyzing how navy helicopter crashes and their casualties over the past century have influenced the design of the navy's helicopter crash training technology. The Social Construction of Technology (SCOT) is a theory within the field of science and technology that argues that technology does not determine human action, but rather that human action shapes technology. The essential idea behind my analysis is that loss, specifically the loss of the lives of precious sailors and marines, has impacted the methods in which the Navy and Marine Corps train their helicopter pilots and crew members.

Between the years of 1969 and 1972, there were seventy-eight Navy helicopter crashes at sea, and, as a result, sixty-three lives were lost. To reverse this trend in fatalities due to aircraft crashes at sea, the Navy began training all flight personnel in the 9D5 Multi-Place Universal Underwater Egress Trainer (Tillison). In my research, I will be specifically analyzing the 9D5 and the technologies it utilizes in order to attempt to effectively train personnel for helicopter crash scenarios. Additionally, I will be comparing the setup of the 9D5 to the most current Egress

Trainer, called the METS. The METS, also called the Helo Dunker, is designed to generate a realistic environment in which personnel can practice procedures for evacuation from a ditched aircraft. METS was developed by the company, Survival Systems Limited (SSL), which was incorporated in 1982. SSL's quality policy states that they are, "committed to the preservation of human life through the development of technologies that provide realistic survival and safety training while addressing risk at all levels of the process" (SSL). The METS incorporates the use of exterior cutout exit panels as well as escape exit panels that replicate actual helicopter escape exits (Mets Trainer). In my research, I will be comparing the effectiveness of the technologies utilized within both the 9D5 and the METS simulators. Additionally, I will be analyzing if and how the technologies used within each egress helicopter training simulators have developed based on past crashes.

Conclusion

In culmination, understanding how technology should be shaped by the lives of individuals is crucial, specifically regarding the development of simulators. All simulators are designed with the purpose of providing an experience that will educate their customer without making them face the real-life consequences of the mistakes and failure that come with gaining this new skill set. These simulators are training individuals to face potential life or death situations. In the case of autonomous driving simulators, the simulator is teaching the self-driving vehicle software how to drive; in turn the simulator is taking on the responsibility of ensuring that the software is properly trained and safe for the drivers and pedestrians within our communities. Similarly, modular egress training simulators are taking on the responsibility of training thousands of helicopter pilots and air crewmen on how to successfully escape their aircraft and in turn death in the chance that it's no longer operational. Both of these simulators

illustrate just how important it is for technology to be designed to meet the changing needs of the individuals within our society. If our technology is not designed based on our past mistakes and failures, we will never be able to grow and enhance as a society.

Works Cited:

Dyer, Andrew. (Sept 5th 2021). Navy identifies 5 San Diego sailors killed in helicopter crash off coast. Retrieved from https://www.sandiegouniontribune.com/news/military/story/2021-09-05/navy-identifies-5-san-diego-sailors-killed-in-helicopter-crash-off-coast

Modular Egress Training Simulator (Mets) Trainer. NAVAIR. Retrieved from https://www.navair.navy.mil/product/Modular-Egress-Training-Simulator-METS-Trainer

NHTSA Releases Q1 2021 Fatality Estimates, New Edition of 'Countermeasures That Work'. (Sept 2nd 2021). NHTSA. Retrieved from https://www.nhtsa.gov/press-releases/q1-2021-fatality-estimates-10th-countermeasures-that-work

SSL Quality Policy. Survival Systems Limited. Retrieved from https://survivalsystemsgroup.com/ssl-quality-policy/

Tillison, Lt. Howard. Performance in the 9D5 Multi-Place Universal Underwater Egress Trainer: Physiological and Behavioral Correlates. *Proceedings of the Human Factors Society Annual Meeting*, vol. 25, no. 1, 1981, pp. 411–415., https://doi.org/10.1177/107118138102500110 8.