Final Year Project Report

**Full Unit – Interim Report**

SELF-DRIVING F1TENTH VEHICLE AND RACETRACK TIME-TRIAL SIMULATION – Interim Report

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# Introduction

In this project, I will be using the F1Tenth simulator to create a program that allows a driverless car to navigate through a racetrack as fast as possible. This will allow me to simulate a race scenario, since this is what the F1Tenth car was created for. By creating this concept, it will help prove that autonomous racing is a safer and more efficient form of racing. Alongside autonomous driving, I will also implement track learning, where the car will have to navigate through an unknown terrain at the fastest rate, like rally car racing. The simulator should be able to provide all the necessary frameworks and tools to accomplish this project.

Throughout the history of car racing, humans driving race cars has been the only way of performing this sport. Accidents have always been a major problem, with over 90% of accidents caused by human error [1]. Some of these have been caused by drivers miscalculating their speed, poor assessment of the track, distractions, fatigue, health, and many other factors. If the driver is affected by external factors, it will potentially impact their performance, either making their track time longer, or cause them to create mistakes which can result in accidents.

Self-driving will allow the potential elimination of human error since losing focus, fatigue and other ‘human factors’ do not affect machines. Self-driving will also allow the car to be able to always drive through the track at its optimal performance, being able to calculate in the moment what would be the best approach for a certain part of the track in real time without any internal factors affecting its decision. If by any chance there was some sort of accident that occurred during driving, there will not be any driver present that could potentially suffer from any harm, creating a safer environment in the racing industry.

The aspect of track learning would create the potential for the self-driving car to race in a condition where the track is currently unknown to the system. By studying the path, it ‘senses’ in front of itself using sensors to identify what its surroundings are, the car will be able to make real-time decisions on its speed and turns it needs to take. With this technology, the car can then be taken into the real world, where these skills can be transferred to traversing unknown paths and tracks with some ease.

The F1Tenth Simulator is one possible way of testing such ideas. This software allows the testing of wall-following capabilities by programming the car to sense walls and drive within their boundaries. By doing so, the car will not need human interaction to drive it, since it can create its own path using the environment it is in. By using odometry and camera, the car can view what is in front of it, being able to track the current environment it is at. Once it tracks the current path, it can store the path and overtime, once it ends driving, the car would be able to recreate the whole path in its storage, even if it has never seen it beforehand [2].

ROS F1/10 Simulator technology has a variety of frameworks that give the capabilities of creating such system that the car can drive automatically and learn the track using its sensor libraries. You can program a track that the car will attempt to stay within and drive to specific locations through different localisation algorithms. An example could be the Monte-Carlo localisation algorithm, which is specific for robots to calculate their coordinates in the environment [3].

Since ROS is a new concept to me, there are a wide variety of documentations and tutorials online to swiftly help me understand the technology to be used within this project. The F1Tenth website [2] supports set up guides, software optimisations and lecture tutorials for understanding ROS. By using these resources that are tailored to the F1Tenth simulator, the learning curve will become much more manageable.

Although this project will mainly focus on the simulator, the F1Tenth hardware can be used to test the car’s capabilities without any risk of damaging the physical car, instead, creating a virtual environment first. After creating this scenario, these components can then be transferred to the physical machine itself to perform the tasks in the physical environment, to see how it performs in a real-life scenario. Within this project’s early deliverables, a report will be created to explain how the simulator’s programming can be transferrable to F1Tenth’s hardware, how sensors and its other components will be used from the simulator’s programming.

# References & Citations

[1]D. Matine, "What Percentage of Car Accidents Are Caused by Human Error? | Virginia Law Blog", *Buck, Toscano & Tereskerz, Ltd.*, 2022. [Online]. Available: https://www.bttlaw.com/what-percentage-of-car-accidents-are-caused-by-human-error/. [Accessed: 30- Sep- 2022].

[2]"Build", *F1tenth.org*, 2022. [Online]. Available: https://f1tenth.org/build.html. [Accessed: 30- Sep- 2022].

[3]R. Ping Guan, B. Ristic, L. Wang and R. Evans, *Monte Carlo localisation of a mobile robot using a Doppler–Azimuth radar*, 97th ed. Automatica, 2018, pp. 161-166.