2Fast2Drive
Project Definition Document

Document Version: **1.0**

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Version History

Date	Document Version	Document Revision History	Document Author/Reviser
December 08, 2019	**1.0**	**Initial Draft**	**2Fast2Drive**

Approvals

Date	Document Version	Approver Name and Title	Approver Signature

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1. PURPOSE

This Project Definition Document provides a brief overview of the 2Fast2Drive Project to promote a shared understanding before a more detailed plan, schedule, and budget is prepared.

2. PROBLEM/OPPORTUNITY

F1tenth is an international contest where vehicles with similar hardware are built and programmed to be fully autonomous. The vehicles compete against each other to obtain the best time. The 2Fast2Drive Project seeks to develop an autonomous vehicle that will meet the standards of the F1tenth Competition.

3. PROJECT GOAL

The goal for this project is to create a miniature autonomous vehicle that will drive around a race track while avoiding collisions with objects.

4. PROJECT OBJECTIVES

1. Assembling mechanical and electrical components of the car.
2. Installing following software on pc:
    1. Ubuntu Xenial 16.04.01
    2. ROS kinetic
3. Installing following software on Jetson TX2:
    - LINUX GUI
    - Jetpack 3.2 flash
    - A re-flash of the Connect Tech Orbitty
    - ROS kinetic
4. Developing collision avoidance system using LIDAR sensor.
5. Developing system capable of following specified path.
6. Developing path planning system.
7. Developing system responsible for acceleration profile and velocity.
8. Developing system responsible for steering control.

5. PROJECT SCOPE

The major deliverables for this project include:

- Functioning project Website
- Fully built F1tenth vehicle
- A computed best path for the vehicle to take around a track
- Vehicle collision avoidance
- Final Presentation

This project is only meant to build a functioning self driving F1tenth car. Anything beyond the automation and build of this car is outside the scope.

6. Key Stakeholders

- Dr. Henry Hexamoor
- Dr. Bardh Hoxha
- Cole Cralley
- Alec Waichunas
- Piotr Baranski
- Ridhi Choudhary
- David McDowell

7. Outcomes/Success Criteria

For this project to be successful, the F1tenth car must be able to complete multiple laps around any given track. The car should use the sensors to identify the layout of the environment and determine when to move forward or to start turning.

8. Assumptions and Constraints

8.1 Assumptions

- Dedicated space to assemble and test car
- Have a desktop with Ubuntu 16.04 to develop and deploy code to car
- The required parts are without faults and delivered on time
- Mentor assistance

8.2 Constraints

- Time
- RobotOS (Operating system of the car)
- Limited space/access
- Learning the python programming language and associated libraries
- The time and understanding of standard machine learning concepts

9. RISKS

The following is the list of potential risks that can impact negatively the project:

- Damages to the car sensors or boards during vehicle testing.
- Integration of different sensor data to determine car motion.
- Inconsistent versions with software and documentation
- Library compatibility and dependencies.
- Time constraints.

10. ESTIMATED COST

Total cost of the project is estimated to be 3592.11. This cost includes all mechanical, electrical and miscellaneous parts of the car.

11. ESTIMATED DURATION

Estimated timeline for project completion is as follows:

Project start date: **10/15/2019**

Project end date: **05/04/2020**

12. FUNCTIONAL REQUIREMENTS

FR1. Vehicle Controller		
Goal: The vehicle will respond to inputs from a wireless controller		
If the vehicle's algorithms don't go as planned, there needs to be an override to take control of the car manually.		
Origin: Team Meeting		
Version: 1.0	Date: 12/07/2019	Priority: 1

FR2. Driving straight		
Goal: The vehicle will drive in a straight line		
For the vehicle to remain on it's calculated path, the first concern is that the vehicle shall not veer off.		
Origin: Team Meeting		
Version: 2.0	Date: 12/07/2019	Priority: 2

FR3. Collision Avoidance		
Goal: The vehicle will stop		
If the vehicle is unsure of the given path, or can't dodge an upcoming obstacle, it will slow down and come to a complete stop and end the current procedure		
Origin: Team Meeting		
Version: 3.0	Date: 12/07/2019	Priority: 3

FR4. Vehicle Turning		
Goal: Vehicle will calculate a path to complete a turn		
In the F1tenth course the vehicle will come across many turns to complete the track. The vehicle must calculate a path and execute along the path, to complete the turn.		
Origin: Team Meeting		
Version: 3.0	Date: 12/07/2019	Priority: 3

13. NON-FUNCTIONAL REQUIREMENTS

NFR1. Sensing		
Goal: To know everything about the environment.		
Vehicle will be using LiDAR, camera and IMU to sense the obstacles, corners, walls etc. in environment.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 1

NFR2. Perception - object detection and tracking		
Goal: The vehicle will use vision and deep learning algorithms to detect static objects.		
The vehicle by using inputs from sensors is going to monitor and track its distance from the walls.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 1

NFR3. Decision		
Goal: Mission and route planning		
The vehicle will generate high-level route based on way-points or map.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 2

NFR4. Steering control		
Goal: Vehicle will calculate adequate steering angle of front wheels		
When turning vehicle needs to calculate steering angle of the front wheels in order to execute planned route.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 2

NFR5. Sensor fusion		
Goal: To merge data of LiDAR, camera and IMU.		
Combining data from multiple sensors is going to provide single understanding of environment, and it will reduce the amount of uncertainty that could be involved in vehicle task and motion planning. Filtering noisy data can be done by using kalman filters.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 2

NFR6. Data preprocessing		
Goal: Reducing down inputs from LIDAR sensor		
LIDAR is capable of sensing in 270 degrees. By reducing down the number of inputs of the LIDAR the vehicle will only receive essential data for path planning etc.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 3

NFR7. LIDAR data representation		
Goal: To convert LiDAR's inputs.		
Converting LiDAR's data into point cloud representation.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 1

14. TECHNICAL REQUIREMENTS

TR1. Vehicle's safety during testing		
Goal: Ensure model's safety during tests		
First tests of the vehicle will be performed in open space. The racetrack will be built from soft materials to ensure vehicle safety.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 1

TR2. Vehicle's must respond to wireless controller within 1 minute
Goal:Ensure Vehicle is responsive to controller
The autonomous vehicle must be responsive to controller.
Origin: Team Meeting

Version: 1.0	Date: 12/08/2019	Priority: 2

TR2. Vehicle must be able to drive at 10 miles per hour		
Goal: Ensure that vehicle is moving fast enough		
Vehicle will be driving autonomously and potentially competing in a race so we must ensure it is moving fast enough.		
Origin: Team Meeting		
Version: 1.0	Date: 12/08/2019	Priority: 2

15. USE CASES

1. Vehicle will relay information to a client (controller)
2. Vehicle will respond to input from a client
3. Vehicle will make decision given input data from sensors
4. Vehicle will attempt to execute the planned path

Our miniature autonomous car will be useful for racing as well as act as a model for a fast autonomous car.

16. DATA ELEMENTS

Data from IMU or LiDAR sensors will be provided in .csv files.

Date: _____

Approved by: _____

Approver Signature: _____

Mentor Name: _____

Mentor Signature: _____