Requirement Document

1 Introduction

1.1 System purpose:

The purpose of the system is to traverse the Auto-Nav Challenge course at the 2020 Intelligent Ground Vehicle Competition. The system will traverse a course defined by white-painted lanes and various obstacles.

1.2 System scope:

This specification establishes the functional, performance, interface and verification requirements for the Florida Institute of Technology Capstone Program, IGVC Robot. The IGVC Robot shall have the capabilities to qualify and compete in the 2020 Intelligent Ground Vehicle Competition Auto-Nav Challenge.

1.3 Definitions:

Obstacles Traffic barrels and similar roadwork barriers, artificial potholes, trees, shrubs, light posts and other man made objects.

Robot The autonomous vehicle (system) which will be completing the course.

Course The area in which the robot will traverse. The course distance will be 600 feet, constrained within a rectangular area of 100 by 200 feet.

Lanes The space on the course the robot must travel within; this is commonly referred to as the Track in the Auto-Nav competition rules. It is defined by white dashed or solid lines that are approximately 3 inches wide and painted on grass. The width of the lane is constrained from 10 to 20 feet wide, with a turn radius not less than 5 feet.

1.4 References:

Igvc.org. (2019). [online] Available at: `http://www.igvc.org/2019rules.pdf` [Accessed 23 Sep. 2019].

1.5 Functions overview:

Lane Detection The robot shall follow the path specified by the Auto-Nav competition. The boundary of this path will be illustrated by dashed or continuous white lines, known as lanes. Lane detection is necessary for the robot to detect these boundaries.

Obstacle Detection Throughout the course, there shall be natural and artificial obstacles. Obstacle detection and avoidance allow the robot to detect obstacles and move around them.

Mapping The robot shall possess the ability to map the environment using the data from lane detection and obstacle detection. Predefined GPS waypoints shall be marked on the map.

Path Planning Using motion planning, the robot shall construct the shortest path to the checkpoints using known data from detection.

2 Performance requirements:

- The robot shall maintain an average speed above 1 MPH while completing the course and any challenges.
- The robot shall not exceed a speed of 5 MPH while on the course or during any challenges throughout the competition.
- The robot shall be able to carry a 20 pound payload while completing the course. If the payload falls from the robot, the run will be ended.
- The robot shall be able to travel with its payload on natural and artificial inclines with gradients not exceeding 15%.
- The robot shall avoid obstacles and stay within the lanes to complete the course without penalty.
- While completing the course, the robot may stop for a consecutive maximum of one minute.
- The robot shall be able to safely function in light rain or drizzle.

3 Functions:

3.1 Lane Detection:

3.1.1 Description:

- A Zed camera shall be used to capture images of the the environment in order to collect data for the subsystem.
- The robot shall detect lane using a computer vision technique and/or a Neural Network.

3.1.2 Input:

- The input will be the images captured from the camera.

3.1.3 Output:

- The output will be the position and outline of the lane

3.2 Obstacle Detection:

3.2.1 Description:

- A Zed camera shall be used to capture images of the the environment in order to collect data for the subsystem.
- The robot may collect distances from obstacles using a device such as LiDAR.
- A Neural Network and/or sensor fusion technique shall be used to find obstacles location relative to the robot.

3.2.2 Input:

- The input will be the data collected from the Zed camera and sensors.

3.2.3 Output:

- The output will be the positions and sizes of the obstacles.

3.3 Mapping:

3.3.1 Description:

- The robot shall be capable of mapping the obstacle course in order to find the path to specified waypoints.
- The robot shall continuously map the course using data from lane detection and obstacle detection.

3.3.2 Input:

- The input will the output provided by the Lane Detection and Obstacle Detection subsystem. Predefined GPS waypoints will be provided by the user.

3.3.3 Output:

- The subsystem will create a gradually generated map of the obstacle map. The map will contain the positions of the robot, the obstacles, the lanes and waypoints.

3.4 Path planning:

3.4.1 Description:

- Using probabilistic motion planning, the robot will plan the shortest path to the waypoints using the data collected.

3.4.2 Input:

- The input will be the map provided by the Mapping subsystem.

3.4.3 Output:

- The output will be the path the robot will travel in the obstacle course.