Land-Based Autonomous Vehicle (LBAV)

Team Number: 22

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Submitted To: Dr. Gupta

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Abstract

The project at hand is to build a land-based autonomous vehicle for the Intelligent Ground Vehicle Competition (IGVC). The vehicle must be able to navigate a course without hitting any obstacles all while remaining within the designated path. The required needs of the project are explained further in the report. So far light project planning has occurred which includes concepts for steering, obstacle avoidance, and image processing. The next steps are to use various design methods, such as the Pugh matrix, to select the optimal devices for the vehicle.

1 Introduction

The objective of this project is to design a land-based autonomous vehicle that can detect and maneuver around obstacles in its path. The path is not predetermined so it is essential that the vehicle has a type of line following or image processing system to stay within the designated path. Configuring the frame to meet the constraints as well as utilizing the previously mentioned image processing systems, in tandem, is the primary goal for the project.

Systems like this do already exist but are not perfected. The Google car is the most well-known of these systems. This car can drive without a driver present and it navigates roads without any accidents.

2 Project Definition

2.1 Background research

The Intelligent Ground Vehicle Competition has been in existence since 1993 and has included competitors from schools such as: University of Michigan - Ann Arbor, the Georgia Institute of Technology, and Yale University [1]. The competition, as it exists today, consists of an autonomous navigation challenge, a design competition, and an interoperability challenge. Despite the competition being in existence for over twenty years there is always room for improvement in the realm of autonomous navigation, for the most part in simplifying logic and making advancements in sensor technology. This technology has been used in aerial, land, and sea vehicles. If autonomous land vehicles are perfected, it will reduce the need for career drivers, such as in truckers, therefore saving companies money in the long run.

2.2 Need Statement

The Land-Based Autonomous Vehicle project is an undertaking of the Florida Agricultural and Mechanical University-Florida State University (FAMU-FSU) College of Engineering cooperating with the Florida Institute of Technology (FIT) to compete in the Intelligent Ground Vehicle Competition (IGVC). The FAMU-FSU side of the cooperative is funded by the Aero-Propulsion, Mechatronics, and Energy (AME) Center. The Advisor and contact at the AME Center is Dr. Nikhil Gupta. There is too high of a demand for vehicle operators in industry.

2.3 Goal Statement & Objectives

The goal of this competition is to design a land-based autonomous vehicle that can detect and navigate around obstacles in its path. Due to the time constraint of this project, there is an overall goal as well as a team goal. The overall goal is to make a competition ready vehicle, but since that is a major task, the team goal is to have a functioning robot that is able to participate, and successfully qualify, in the straight away at the beginning of the competition.

2.4 Constraints

Below are the requirements that the intelligent ground vehicle must meet in order to consider it as a valid design and as well qualify for the Intelligent Ground vehicle (IGV) competition. A small semi-rugged outdoor vehicle is required for the competition, the requirements to be met includes [1]:

- **Design**: The vehicle must be designed such that it is mechanically propelled on its direct contact (traction) with the ground through the wheels.
- **Width:** Two feet is the minimum width required and four feet at maximum.
- **Height:** Apart from the emergency stop antenna, the height of the vehicle must exceed six feet
- **Length:** The vehicle must be at least three feet long with maximum length of seven feet.
- **Propulsion:** The power required for propelling the vehicle must be generated onboard.
- **Speed:** At minimum the speed of the vehicle must be one mph and five mph at maximum.
- **Mechanical E-stop location:** The E-stop button required must be red in color, push to stop and one inch diameter at minimum. Even if the vehicle is moving, the button must be easily identified and can be safely activated with its location at the center rear of the vehicle with minimum height of 2 feet from the ground and four feet at most. The E-stop must not be software controlled, but must hardware based and on activation must be able to bring the vehicle to a prompt and full stop.
- **Wireless E-stop:** For a minimum of 100 feet the wireless E-stop must be effective. Hardware based E-stops that cannot be controlled using software is required. The wireless E-stop is expected to bring the vehicle to a quick and complete on activation.
- **Safety Light:** At any time when the vehicle power is turned on, an easily viewed solid indicator light must be recognized on the vehicle. A solid light which turns to flashing when the autonomous is activated and again turns solid when the autonomous mode is off is required.
- **Payload:** The vehicle must be able to carry a load of 20-pound securely mounted on the vehicle. The specifications of the payload is 18 inches long, 8 inches wide and 8 inches high.
- **Lane following:** The vehicle must be capable of detecting and following lanes.

- **Obstacle Avoidance:** The vehicle must be capable of detecting and as well avoiding obstacles.
- **Waypoint Navigation:** Vehicle must show its capability of finding a path to a single two meter navigation waypoint by maneuvering its way round the obstacle.

2.5 Methodology

The LBAV project will be divided into the general subsystems of mechanical and electrical components. The mechanical systems can be further broken up into frame design, drive-train, and braking. The electrical systems will be split into the subsections of processing, sensory devices, and controls systems.

Table 1: House of Quality for LBAV

	Engineering Characteristics		
Design Requirement	Material	Cost (USD)	Weight (pounds)
Size	◊	▲	○
Speed	◊	○	▲
Functionality	▲	○	◊
Power	◊	○	◊
Absolute Importance	18	27	21
Relative Importance	27	41	32
E.C. Rankings	3	1	2

Legend
▲strong (9)
○ medium (6)
◊ weak 3 (3)

3 Conclusion

The primary goal for this project is to design a competition ready, land-based autonomous vehicle. Due to the time constraints this task can be a formidable one. The secondary goal is to have a vehicle that can successfully qualify for the competition. This means that the vehicle must complete a 44 feet straight away while keeping a minimum speed of 1 m.p.h. Future tasks include material selection, control selection and power selection.

4 References

1. "IGVC - Intelligent Ground Vehicle Competition." *IGVC - Intelligent Ground Vehicle Competition*. N.p., n.d.Web. 24 Sept. 2015.