Land-Based Autonomous Vehicle (LBAV)

Project Plan and Product Specs

Team Number: 22

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Submitted To: Dr. Gupta

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Problem 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.

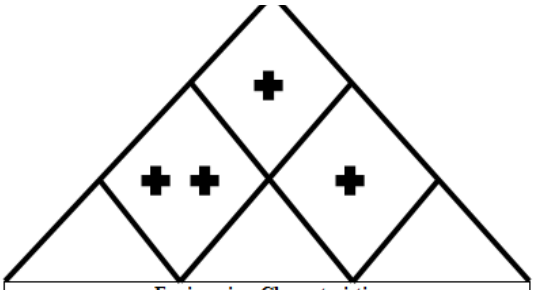
Project Goal

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.

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



	Engineering Characteristics		
Design Requirement	Material	Cost (USD)	Weight (pounds)
Frame	◊	▲	○
Speed	◊	○	▲
Sensor	◊	▲	◊
Power	▲	○	◊
Locomotion	▲	◊	◊
Absolute Importance	27	33	24
Relative Importance	32	39	29
E.C. Rankings	2	1	3

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

Project 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:

- **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.

Assign Resources

Team Leader: Julian Wilson

Manages the team as a whole; develops a plan and timeline for the project, delegates tasks among group member according to their skill sets; finalizes all documents and provides input on other positions where needed. The team leader is responsible for promoting synergy and increased teamwork. If a problem arises, the team leader will act in the best interest of the project.

He keeps the communication flowing, both between team members and Sponsor. The team leader takes the lead in organizing, planning, and setting up of meetings. In addition, he is responsible for keeping a record of all correspondence between the group and 'minutes' for the meetings. Finally he gives or facilitates presentations by individual team members and is responsible for overall project plans and progress

Financial Advisor: Isaac Ogunrinde

Manages the budget and maintains a record of all credits and debits to project account. Any product or expenditure requests must be presented to the advisor, whom is then responsible for reviewing and the analysis of equivalent/alternate solutions. They then relay the information to the team and if the request is granted, order the selection. A record of these analyzes and budget adjustments must be kept.

Lead ME: Dalton Hendrix

Takes charge of the mechanical design aspects of the project.
Keeps line of communication with the lead ECE.
He is responsible for knowing details of the design, and presenting the options for each aspect to the team for the decision process. Keeps all design documentation for record and is responsible for gathering all reports.

Lead ECE: Allegra Nichols

She is responsible of the EE, IE, or CE design part in support of the project. She maintains line of communication with the lead ME. She keeps all design documentation for record.

Product Specifications

Design specifications

The intelligent ground vehicle will include a cinder block pay load of 20 lbs.

Perception

Image processing is a vital piece to a responsive and well verse unmanned vehicle. A NI myRIO 1900 microcontroller with a camera will be used to control the unit. The camera will feature a monocular lens to increase the field of view for the vehicle. Data will be transmitted for the sensors and the camera to the controller to filter out and properly detect obstacles.

Sensor/Lights

Sensors will be used to measure and detect object avoidance and proximity. Front, rear, and side sensors are needed to properly detect objects. Sensor placement is the most important aspect of using the sensors. Ultrasonic sensors will measure the position of objects close to the vehicle. A solid indicator light will signify the vehicle is on and it will begin flashing when autonomous mode is activated. LEDs will be used for the light

Emergency Stop

A physical push-to-top button will be used to top the vehicle immediately. The button will be located in the center rear and will be both mechanical and wireless. Range is the most important aspect of the wireless emergency stop.

Propulsion

The vehicle will have power generated onboard. Fuel storage or running of internal combustion engines and fuel cells are not permitted, therefore; Lithium batteries will be used. Specifics of the propulsion system for the intelligent vehicle will be further determined as the product is developed and tested.

Housing

The unit will be a small, semi-rugged outdoor ground vehicle. The housing will be fabricated out of a quarter inch square aluminum tubing. When designing the housing for the vehicle, the modifications for adding and changing sensors should be easily accessible. Natural and artificial inclines and weather conditions should be taken into account.

Steering

Differential steering, movement based on two separate driven wheels, will be used for the vehicle because it provides for a more efficient range of motion, and better agility to maneuver around obstacles.

Motor

Motor selection is the most vital aspect of the vehicle. In selecting a motor, RPM, and diameter are the most essential aspects. In considering the design expectations of the vehicle, a minimum of 3/4 m/s to a maximum of 1 m/s will be considered for RPM.

Performance specifications:

The vehicle will use perception to detect alternating side-to-side dashes or solid white path on an outdoor surface, and to detect and avoid objects such as construction barrels, trees, and potholes. The wireless E-stop should be effective for a minimum of 30m.

Task Name	Start	Finish
Team building	Tue 9/1/15	Wed 9/2/15
Code of conduct	Wed 9/9/15	Thu 9/10/15
Code of conduct deliverable	Fri 9/11/15	Fri 9/11/15
Staff meeting	Thu 9/17/15	Thu 9/17/15
Sponsor meeting	Mon 9/21/15	Tue 9/22/15
Needs for assessment	Sat 9/19/15	Wed 9/23/15
Needs for assessment deliverable	Fri 9/25/15	Fri 9/25/15
Revised code of conduct deliverable	Fri 10/2/15	Fri 10/2/15
staff meeting	Thu 10/1/15	Thu 10/1/15
Sponsor meeting	Tue 10/6/15	Tue 10/6/15
Project plans and product specs	Wed 10/7/15	Thu 10/8/15
Project plans and product specs deliverable	Fri 10/9/15	Fri 10/9/15
Initial web page design	Sat 10/10/15	Wed 10/14/15
Initial web page design deliverable	Thu 10/15/15	Thu 10/15/15
Midterm presentation I: Conceptual Design	Thu 10/15/15	Tue 10/20/15
Midterm presentation I: Conceptual Design deliverable	Tue 10/20/15	Thu 10/22/15
Midterm report 1	Sat 10/24/15	Thu 10/29/15
Midterm report 1 deliverable	Fri 10/30/15	Fri 10/30/15
peer Evaluation	Tue 11/3/15	Thu 11/5/15
Midterm presentation II: Interim Design Review	Wed 11/11/15	Mon 11/16/15
Midterm presentation II: Interim Design Review deliverable	Tue 11/17/15	Thu 11/19/15
Peer evaluation	Tue 11/24/15	Tue 11/24/15
Final web page design	Wed 11/18/15	Mon 11/23/15
Final web page design deliverables	Tue 11/24/15	Tue 11/24/15
Final design poster presentation	Wed 11/25/15	Mon 11/30/15
Final design poster presentation deliverable	Tue 12/1/15	Tue 12/1/15
Final report	Wed 11/25/15	Mon 11/30/15
Final report deliverable	Tue 12/1/15	Tue 12/1/15
Bi-weekly staff meetings