Design Team 2

Eyes & Ears

Land ROOver

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Abstract

A sensor system is needed for the Land ROOver autonomous vehicle that is being developed for entry in the 2008 Intelligent Ground Vehicle Competition (IGVC). To achieve success, this system must be able to detect lane markings, determine the location and orientation of the vehicle, and ascertain the position of obstacles in the vehicle's path. The information gathered will be compiled into a grid that maps the vehicle's surroundings as it traverses the course. An additional team will use the map to make decisions concerning vehicle movement. The following summarizes the design of the sensor system that will be the "eyes and ears" of the Land ROOver vehicle.

Design Specifications Summary

Mechanical Requirements

• Total weight of all sensors must be less than 100 lbs.

Power Requirements

• Maximum power delivered to sensors must be less than 35 W.

Control Design

• Must be able to detect painted white and/or yellow lines in grass, whether solid or dashed, that are 3 inches in width.

• Must be able to detect simulated potholes, two foot diameter circles painted white.

• The GPS must be accurate to at least 1m.

• The vehicle must detect obstacles that lie within a field of view of 100 degrees and a distance of 9 feet from it.

• The vehicle must determine the location of obstacles to within 20cm of their actual location.

• Data from sensors must be processed and assembled into a grid of the vehicle's surroundings within 1 second.

• The resolution of one square on the sensed map grid will be no worse than an accuracy of 20cm x 20cm.

• The grid developed by the sensors that describes the vehicle's surroundings will be made available in software to the Arms & Legs team for motion control decisions.

Communication

• All data communication between sensors and the controller will be accomplished serially.

Radiation Design

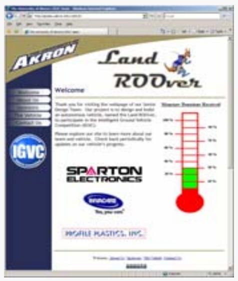
• The sensors must be located on the vehicle such that the radiated EMI that is generated by the vehicle drive circuitry does not affect sensor operation.

Economic and Ergonomic Design

• The sensors must operate properly within a temperature range of 30°-90°F.

Software

• Programming and interfacing will be handled using the LabView and C languages.



Please visit our team's website at http://gozips.uakron.edu/~jhb10 to keep up to date with the vehicle's progress and learn how to sponsor our team

Competition Description

Autonomous Challenge

The Autonomous Challenge requires a team's vehicle to navigate through a course marked by white painted lines, and containing varying objects. The objective of the competition is to make it to the end of the course without hitting any obstacles or crossing over any lines in the shortest time possible. Teams are allowed to use any means possible to achieve this as long as the vehicle is not controlled by a human and the sensing equipment is non-tactile.

Autonomous Vehicle Navigating Autonomous Challenge Course

Design Challenge

The Design Challenge asks teams to illustrate the design strategy and process by which the team's vehicle is produced. Particular attention is given to a team's ability to achieve an innovative strategy for the design of the vehicle. Teams are asked to portray these things in both a written design document and oral presentation.

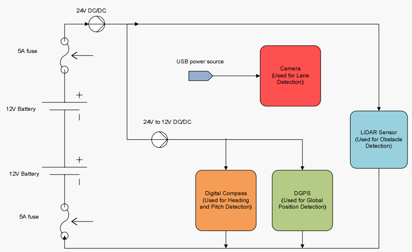
Team Presenting Their Vehicle Design

Navigation Challenge

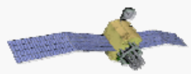
The Navigation Challenge course requires the vehicle to steer through a course riddled with various obstacles in order to reach a number of predetermined waypoints. The objective of the competition is to reach each of the waypoints in the shortest time, without hitting any obstacles or going out of bounds.

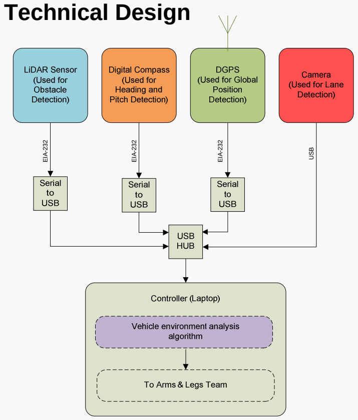
Autonomous Vehicle Navigating Through Navigation Challenge Course

Technical Design

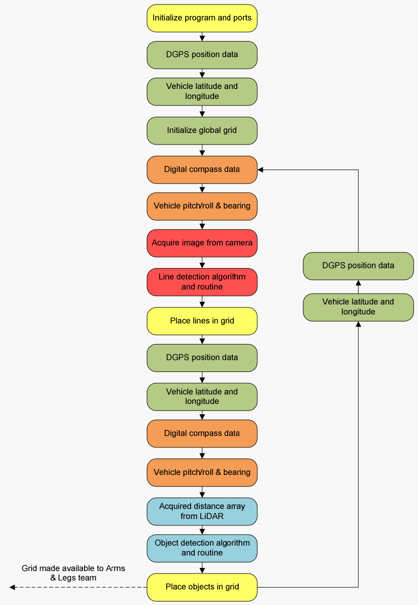


Power Distribution Block Diagram





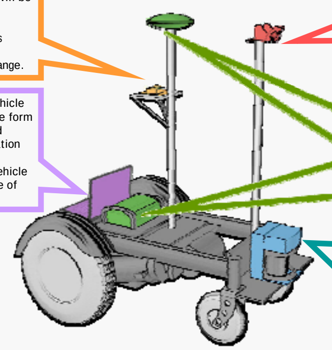
Hardware Structure Block Diagram



High Level Software Structure Block Diagram

Digital Compass: The digital compass will be used to detect vehicle heading and tilt angles for both the LiDAR and camera systems. The team has chosen a 3-axis magnetoresistive compass that has the capability to detect a 0.3° heading change.

Laptop Computer: In order for the vehicle to compile all sensor information, some form of computing is necessary. An onboard laptop will allow for all sensor information to be interpreted, built into a grid describing vehicle surroundings, and vehicle control will be decided through the use of the grid



Camera: In order to sense and detect painted white lines on either of the competition courses, some form of line detection is necessary to achieve lane avoidance. The team has chosen to use a digital camera, mounted high on the vehicle to give the camera a wide range view of its surroundings.

DGPS Receiver and Antenna: One major aspect of the navigation challenge is to navigate a course through the use of a Global Positioning System (GPS). Waypoints are 2m in diameter circles, so a highly accurate GPS receiver is required. A Differential GPS (DGPS) will be employed to achieve the needed accuracy. A DGPS receiver is simply a GPS receiver that accepts a correction signal to account for errors that degrade performance. The team has chosen to use the Novatel Propak-V3-HP receiver with GPS-702L antenna, which receives differential signals from the Omnistar satellite system. The achievable accuracy with this system is 10cm, and can be easily interfaced with a PC through a serial EIA-232 connection.

Scanning Laser Range Finder: In order to sense and avoid obstacles encountered on either of the competition courses, some form of obstacle detection is necessary to achieve obstacle avoidance. The team has chosen to use a scanning laser range finder that uses Light Detection and Ranging (LiDAR), an optical sensing technology that measures the time of flight of laser pulses to sense a distance to an object. The range and accuracy of this type of sensor varies from manufacturer to manufacturer, however, the team has chosen to use the SICK LMS291-S05.

Sensor Layout and Descriptions

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