Notre Dame Baja

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1 Introduction

The Notre Dame Baja team is a Baja car design team staffed with Notre Dame students that designs and races their own Baja vehicle against other colleges around the country. These competitions consist of a variety of scoring areas, including dynamic events, such as hill climbs and maneuverability events, and static events, such as design evaluations and presentations. Historically the Notre Dame team has performed very well, finishing 32nd out of 118 teams in 2012 at their annual competition in Peoria, Illinois. The team is shooting for a top-10 finish this summer at the competition in Peoria, Illinois.

2 Problem Description

One aspect of the judging that the Baja team is looking to improve on is their electrical design. The Baja team hopes to add a user-friendly instrumentation system that will both help them score more points with the judges and also help them justify their design choices. Our senior design team plans to take on this challenge to help the Notre Dame Baja team reach its goal for the competition in June 2014.

Our team is responsible for installing the electrical system for the Baja car. Our final system will address the issues in checking and monitoring the engine and wheel speed, locating the Baja car in a race track, and storing the data to update the performance of the car. The system must also contain a way of tracking and recording lap times, and must provide all of the information to the driver in a legible manner. Because the car will be competing in a muddy racing environment and judged on a number of factors, there are also many other considerations we must overcome.

3 Proposed Solution

Our solution will be mounted in the Baja car and will consist of several different components. First of all, our solution will require a number of sensors to monitor the specific metrics the Baja team wants to track. These sensors will feed data into a central unit, probably mounted next to or in front of the driver. It is important that the central unit is near the driver because it will also house a monitor on which the driver can view vehicle performance and track lap data. After use, the central console can be detached from the vehicle and taken inside for data extraction. As track conditions are unknown but presumed muddy, the proposed solution must also be water and mud-proof, so as is can survive in the race environment.

4 Demonstrated Features

The system we construct will record and store data for the following measurements:

- Engine speed
- Wheel speed (rpm and mph)
- GPS location
- Lap time

The system will have the following additional functionality:

- Data sent to the central unit will be stored on a memory card and accessible through a port on the unit.
- GPS data, once extracted, can be used to track lap routes to monitor how efficient the driver is.
- Data will be displayed in real time to the driver via a display on the central unit.
- Drivers can indicate when a lap is done by pressing a button on the central unit.

The following must also be taken into consideration:

- Sensors must be able to integrate within the Baja design.
- Central unit must be able to be mounted near the driver.
- Design must be lightweight.
- Design must be weatherproof and mud-proof for use in competitions.
- Design must be as small as possible to maximize room for the driver and other features on the Baja vehicle.
- Design must meet the budget requirement.

5 Available Technologies

To power our system we will have access to the Baja's 12V battery. For our display monitor we will look into LCD and seven segment displays. The central unit will be built around a standard microcontroller which will intake data from the sensors and save it to an SD Card. The circuit board of the central unit will have input ports for all of the sensors as well as an interface for the SD Card. In addition it will need a power port to get power from the battery and any power electronics components needed to provide the appropriate supply voltage to the microcontroller. The board will also need a USB or mini/micro USB port to transfer data from the SD card to a computer for analysis. Existing technologies for sensors that we intend to pursue include mechanical magnet-based sensors, hall-effect sensors, IR sensors, and reed switches. Having checked with the Notre Dame Baja Design team, all options could be used without interfering in the mechanical design of the vehicle.

6 Engineering Content

Sensors and Data Measurement:

The main challenge of this project will be to program the microcontroller in our central unit to receive data from the vehicle sensors and convert it into a meaningful form. When receiving the data it will be important to program the microcontroller with the appropriate frequencies to prevent the sensor data from containing inconsistencies and flukes.

Lap Timer:

The central unit will also have a button for the driver to log a completed lap, so the microcontroller will have to be programmed to respond to user inputs and log data accordingly.

Data Storage:

Once the data is being collected accurately and converted to in a meaningful form in the microcontroller we need to program the microcontroller to save this data to an SD card. The SD card can then either be removed, or have an output port through which the data can be downloaded.

Real Time Display:

Once the data is collected the microcontroller must then output it in real time with a visual display. The visual display will need to either have multiple different displays to provide all of the relevant data or be programmed to switch between metrics at a given rate. If the display only shows one metric at a time, the display should be programmed so that the driver can interact with the central unit to switch between performance metrics.

Environmental Considerations:

Furthermore the design must be engineered with the environment in mind, understanding that these vehicles will be in a wet, hot, muddy environment, and all features and functionality must be able to withstand these conditions. Throughout the system development process, each function will be tested on a prototype car before the overall system is installed in to the Baja car. Similarly, the design must also be small enough to fit inside the Baja car easily, and lightweight enough to avoid hindering the car's performance.

7 Conclusions

This project has the opportunity to greatly improve the Notre Dame Baja's efforts in their summer competition. By installing the electrical system and allowing for data analysis, the team will be able to monitor the performance and optimize their vehicle before the competition. With more data available, the team will be able to provide much stronger arguments for their design decisions when questioned by the judges this coming summer. In addition to aiding the team overall, the display function of the system will help the Baja driver improve performance by allowing him or her to monitor and track lap times as well as lap routes. Finally, the weatherproof and mud-proof packaging of electrical system will be crucial to avoid any malfunction of the system during the competition.