TELEMETRY AND DATA LOGGING IN A FORMULA SAE RACE CAR

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ABSTRACT

The problem with designing and simulating a race car entirely through CAD and other computer simulations, is that the real world behavior of the car will differ from the results outputted from CFD and FEA analysis. One way to learn more about how the car actually handles, is through telemetry and data logging of many different sensors on the car while it is running at racing speeds. This data can help the engineering team build new components, and tune the many different systems on the car in order to get the fastest time around a track as possible.

KEY WORDS

Formula SAE, Data Logging, Data Acquisition, Telemetry

INTRODUCTION

Formula SAE is an engineering competition where students are given the task of designing, building, and testing an open wheel, autocross racecar. Teams must work within a strict set of rules to optimize their car for a low cost, high performance setup. Each year, a new car is built entirely from scratch, using knowledge and data gathered from previous testing.

The goal for this system is to accurately log data to an excel spreadsheet, and then display that data to a simple GUI so that an engineer can see what is currently happening with the car. This sensor data is critical, because computer simulations are not always completely accurate. By finding discrepancies between these computer simulations and real-world data, an engineer can change the setup of the car until they reach peak performance.

There are a few different parts to the data acquisition (DAQ) system. First, the different sensors around the car measure parameters such as acceleration, wheel speed, steering angle, etc., and output different voltages depending on the measured value. Second, the Engine Control Unit (ECU) measures these sensors, and controls outputs such as fuel injection and shifting. The ECU also sends data to the Data Logger through a Controller Area Network (CAN) Bus. The third part of the system is the Data Logger, which records sensor and ECU data to help engineers tune other parts of the car's handling. Lastly, a laptop is needed to be able to view recorded values from the Data Logger, and manipulate outputs in the ECU.

INITIAL SYSTEM DESIGN

The DAQ system had to be designed with a few constraints in mind. First, the system had to be reasonably priced, with a maximum cost of $500. Second, the system had to be lightweight, as any extra weight in a racing car causes slower lap times, even if only by a few tenths of a second. Third, every part of the system had to give a decent performance gain, because having more sensors does not justify slower lap times. Finally, the system could not be overly complex, because of the limited time for research and production. The decision matrix below was used to justify which sensors would be helpful. The scoring ranged from 1 to 5, where 1 is the least ideal, and 5 is the most ideal. Only sensors with a score higher than 12 were used.

Sensor Description	Cost	Weight	Performance	Complexity	Total
Steering Angle	5	5	3	5	18
Suspension Travel	2	4	4	4	14
Accelerometer	4	4	5	4	17
Gyroscope	4	4	5	4	17
Thermal Tire Cameras	1	1	4	1	7

Tire Camber Measurement	2	3	3	3	11
Wheel Speed Sensors	3	4	2	4	13

The second challenge with our system was sending data from the Data Logger, and storing it on an excel spreadsheet on a computer. Our team found two ways to tackle this problem. The first way to transmit data would include transmitting through a WiFi antenna on the car, and into a WiFi antenna directly connected to a computer. The second method included setting up two arduino uno modules that could send data over bluetooth radio. We scored the decision matrix below from 1 to 20, with 1 being the most ideal and 20 being the least ideal solution.

System Description	**Parts**	**Cost**	**Complexity**	**Total**
WiFi antenna		9	10	22
	Mobile Antenna	5	4	
	Base Station Antenna	8	5	
Arduino Radio		8	12	20
	Mobile Arduino	4	6	
	Base Station Arduino Uno	4	6	

CONCLUSION

Since our telemetry system is still in progress, we can't test our data transmission feature yet. So far, we have done extensive testing on reading sensor data accurately and logging the results. This feature has already proven to be helpful, as we have been able to tune our car to compensate for discrepancies between our simulation data and our real world data. Our team is working to quickly develop the wireless transmission feature, because this will help our engineers fix various problems much faster.