FORMULA CAR DATA ACQUISITION SYSTEM

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ABSTRACT

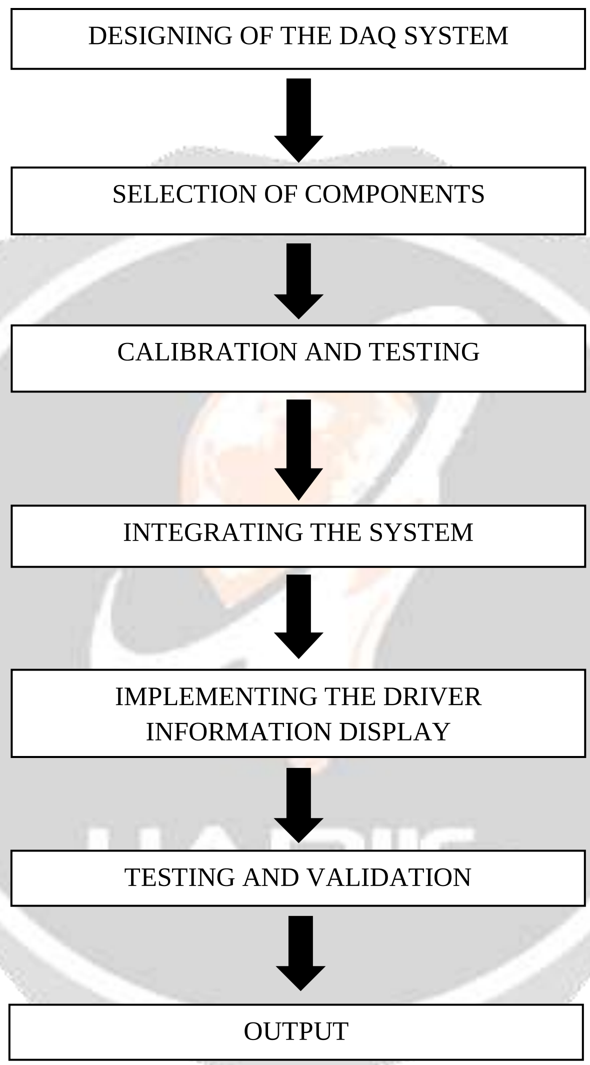
The design, development, and testing of a data acquisition system for a race car are covered in this project report. The system's goal is to gather and examine various data points that are vital for optimising driver safety and performance of the vehicle. A microcontroller device and many sensors make up the data acquisition system. The sensors track the vehicle's acceleration, temperature, brake pressure, suspension travel, and speed. The microcontroller unit gathers sensor data and transmits it to the system-connected storage device. After processing the data, the computer presents it in an approachable way. On a race track, the system was thoroughly tested, and the outcomes were compared to the information from a commercially available data acquisition system. The comparison revealed that, although it is far less expensive, our system performs comparable to the commercial system. Overall, this study shows that it is possible to create a low-cost data collecting system for race vehicles that may offer helpful information about the performance of the vehicle and aid the driver in making decisions on the course. The system is scalable to different uses, such as monitoring and managing other types of vehicles, thanks to its modular architecture and wireless connection.

Keyword : - *Data Collection, Data Storage, Low-Cost*

1. INTRODUCTION

University students are challenged to design, construct, and race formula style cars in the international Formula Student championship. Teams must not only create a car that is quick and dependable but also optimise its performance utilising data analysis and engineering principles in order to win the race. In order to make wise judgements on the track, drivers must also have access to real-time data about the behaviour and performance of the vehicle. I have created, put into practise and tested a data collecting system and driver information display for a Formula Student car to accomplish this. The system gathers information on the behaviour of the car, including speed, acceleration, orientation, and temperature, using a number of sensors and a microcontroller unit. A graphical user interface is then used to analyse and present this data in real time. The purpose of the driver information display is to give the driver current data about the performance and behaviour of the vehicle. This contains critical parameters like engine temperature and oil pressure as well as warnings for important indicators like speed, RPM, lap time, and gear position. The display is simple to operate and made to be readable outside in direct sunlight. The system and display have been integrated into a Formula Student vehicle, which has undergone testing and comparison with vehicles from other competing teams. The system's data collection and display to the driver have enhanced the vehicle's performance and given the driver insightful knowledge about how the vehicle will behave on the track. The development of a data gathering system and driver information display for Formula Student vehicles is demonstrated here as well as its viability and possible advantages. The system and display help teams gather and analyse important data, giving insights into the performance and behaviour of the car. They also give drivers real-time information to help them make decisions on the racecourse. In the end, this increases the team's chances of winning the competition. A wider range of motorsports enthusiast can use the system because of its relatively low cost and user-friendly design, and its modular construction and wireless connectivity make it adaptable to uses other than racing. The overall goal of this research is to show that it is feasible and could be advantageous to create low-cost, user-friendly data collecting devices for use in racing and other fields

1.1 METHODOLOGY



2. SELECTION OF THE COMPONENTS

AUTOMOTIVE ENGINE: The automotive engine is the heart of the formula student car. It converts the fuel into mechanical energy that drives the vehicle. In a race car data acquisition system, sensors are placed on the engine to monitor its performance, including factors such as RPM, throttle position, oil pressure, and temperature.

ECU: The ECU (Engine Control Unit) is a computer that manages the operation of the engine. It receives data from various sensors and makes adjustments to optimize engine performance. The ECU can also communicate with other systems in the vehicle, such as the suspension and transmission control systems.

MICRO-CONTROLLER UNIT: The micro-controller unit (MCU) is a small computer that manages the data acquisition system. It receives data from various sensors and stores it in memory for later analysis. The MCU can also process the data in real-time, for example, to display information to the driver on the intelligent display.

NEXTION INTELLIGENT DISPLAY: The Nextion intelligent display is a touch screen display that can be programmed to display data in various formats. In a race car data acquisition system, the display can be used to show real-time data to the driver, such as speed, RPM, and temperature.

SD CARD MODULE: The SD card module is used to store data from the data acquisition system. As data is collected from the sensors, it is saved to the SD card for later analysis. The SD card can be removed from the vehicle and data can be transferred to a computer for further processing.

LINEAR POSITION SENSOR: The linear position sensor measures the position of a moving part in the vehicle. In a race car data acquisition system, linear position sensors can be used to measure the position of the throttle pedal, brake pedal, or suspension components.

PROXIMITY SENSOR: The proximity sensor detects the presence of an object without physical contact. In a race car data acquisition system, proximity sensors can be used to detect the position of suspension components or to measure airflow around the vehicle. The sensor gives the output in form of Pulse Width Modulations (PWM).

RGB LED STICK: The RGB LED stick is a strip of LEDs that can change color. In a race car data acquisition system, the LED stick can be used to indicate different conditions, such as the state of the engine or the speed of the vehicle.

THERMOCOUPLE: The thermocouple is a temperature sensor that measures the temperature of an object. In a race car data acquisition system, thermocouples can be used to measure the temperature of the engine, exhaust system, or brakes.

VOLTAGE SENSOR: The voltage sensor measures the electrical voltage in a circuit. In a race car data acquisition system, voltage sensors can be used to monitor the battery voltage or the voltage output of sensors.

BUCK CONVERTER: The buck converter is a type of voltage regulator that converts a higher voltage to a lower voltage. In a race car data acquisition system, buck converters can be used to provide a stable voltage supply to the data acquisition system.

PRESSURE SENSOR: The pressure sensor measures the pressure of a fluid or gas. In a race car data acquisition system, pressure sensors can be used to measure the oil pressure, fuel pressure, or boost pressure in the engine.

3. DAQ SYSTEM DEVELOPMENT PROCESS

Fig -1: DAQ System Testing

3.1 CALIBRATION AND TESTING

To replicate the sensors' actual operating environments, a calibration rig needs to be built up. In order to do this, a controlled environment must be created so that the sensors may be evaluated in various scenarios. Data from the sensors is gathered under various settings as part of the calibration process, and it is compared to predetermined values. To do this, change the temperature, pressure, or other factors and observe how the sensor reacts. The accuracy of the sensor should be checked after the calibration tests have been completed. To make sure the sensor is delivering reliable data, this requires comparing the sensor readings with known values. The data gathering system should be tested overall after the sensors have been calibrated and tested. Data from all the sensors must be gathered, and their accuracy and dependability must be confirmed.

3.2 INTEGRATING THE DAQ SYSTEM

Installing the sensors in the proper places on the car was the first stage. For each parameter to be measured, the best sensor had to be chosen, and it had to be mounted firmly at the designated location. Often, brackets, screws, or sticky tape were used to mount the sensors. Running wiring from the sensors to the data gathering devices was the following stage. In order to do this, the wire gauge and insulation for the sensor signal and power lines needed to be chosen. Care was taken when running thewires along the car's frame or bodywork to prevent interference with other parts and to safeguard the wires from harm. The data collecting hardware was added once the wiring and sensors were set up. This normally entailed putting the SD card module and the microcontroller unit in a secure area of the vehicle. Often, sticky tape, screws, or brackets were used to mount the hardware. Configuring the data collecting device was the last stage. This required setting up the SD card module to store the data, configuring the display to display real-time data, and configuring the microcontroller unit to read data from the sensors. The configuration procedure includes setting up the display using the Nextion software and programming the microcontroller unit using a software development kit. After being incorporated into the Formula Student car, the data acquisition system underwent a rigorous testing process to make sure that all the sensors were producing accurate data and that the hardware for data collecting was functioning properly.

3.3 IMPLEMENTING THE DRIVER INFORMATION DISPLAY

The driver information display was put into place to give the driver feedback on the operation of the vehicle in real-time. The system was thoroughly tested to assure accuracy and dependability, and the display hardware and software were chosen based on their fit for the purpose. Because to its excellent resolution, small size, and simple integration with the data collecting system, the Nextion Intelligent Display was chosen as the hardware for the driver information display. The information presented on the display was placed such that the driver could see it with ease. The driver information display's user interface was created using the Nextion programme. It was possible to create unique gauges, graphs, and text with the software. The interface was created using software, which was then mapped to the sensor data. By a serial interface, the data acquisition system's microcontroller unit and Nextion Intelligent Display were joined. The display was set up to take data from the microcontroller unit and show it on the graphical user interface in real time. Data including speed, RPM, battery voltage, coolant temperatures, braking pressure, and suspension data were all encoded into the system for display. To make sure it was giving accurate and trustworthy data, the driver information display underwent a number of rigorous tests. The system was tested under a range of circumstances, including varying speeds, temperatures, and climatic conditions. Any problems were fixed, and the system was improved to make sure it was giving the driver the most helpful data possible. Overall, the driver information display was implemented well, giving the driver real-time data on the vehicle's performance that was helpful in maximising the vehicle's performance on the track.

Fig -1: Steering CAD Model

Fig -2: Display Under Testing

3.4 TESTING AND VALIDATION OF DAQ SYSTEM

A test track was formed with several sections, including straightaways, twists, and curves, to replicate various racing conditions. Reference points were placed along the track to serve as checks on the veracity of the information the system had gathered. The Formula Student car had the data collecting equipment fitted, and data was gathered over the course of several laps around the test track. The information comprised sensor values for the temperature, engine RPM, and vehicle speed. A high accuracy GPS system and other sensors, such a dyno, were utilised to gather reference data and offer ground truth information for particular characteristics, like engine power output. To detect any discrepancies or inaccuracies, the reference data and the data collected by the DAQ system were compared. To determine how well the two data sets agreed, correlation analysis was used. The DAQ system was calibrated to address any inaccuracies discovered during the data comparison if there were any differences or errors. On the test track, the calibrated DAQ system was then put through another round of testing and validation to make sure it was accurate and dependable. The testing and validation procedure was iterative; changes to the system were made, and the process was repeated until the system's accuracy and dependability were determined. Overall, a thorough methodology was used throughout testing and validation to guarantee the accuracy and reliability of DAQ System.

Fig -3: Team Sakthi Racing’s SR22 Under Testing With the DAQ System

Fig -4: SR22 Under Testing

Fig -5: Display Integrated With the Vehicle

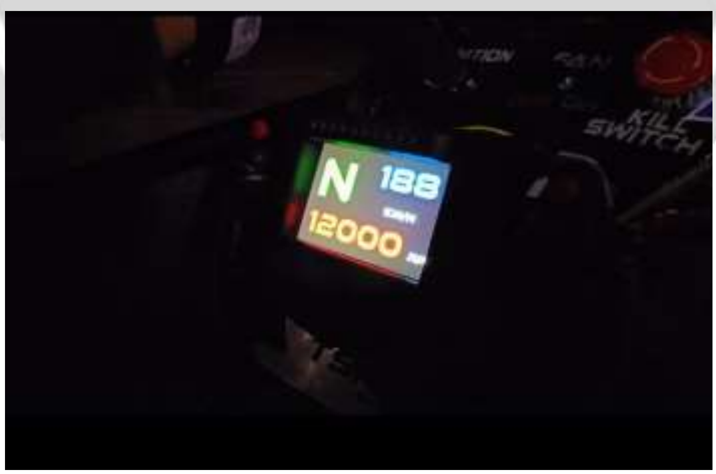


Fig -6: Test run with the Display

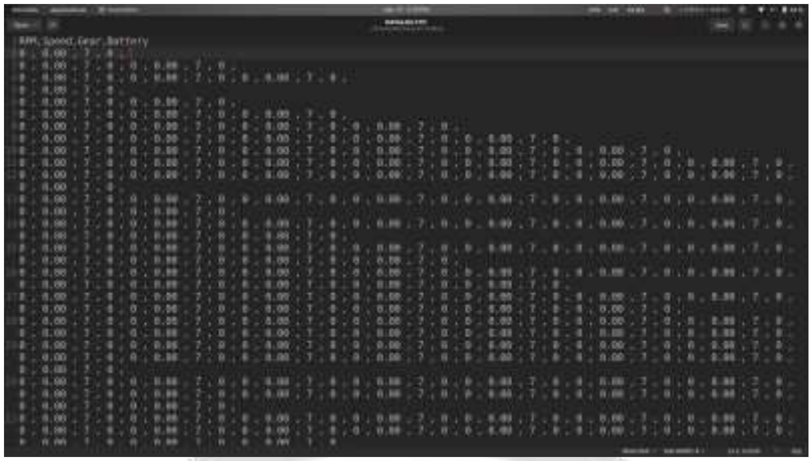


Fig -7: Logged Data Output Viewed on Notepad

4. CONCLUSIONS

As a result, this project has successfully created, put into practise, and tested a data gathering system for a race car that can gather and evaluate many metrics essential for enhancing performance and assuring safety. The system uses a microcontroller unit and a number of sensors. The system has undergone rigorous testing on a racecourse, and the outcomes show that it works comparably to commercially available systems while being far less expensive. The platform is relatively simple to utilise and sufficiently flexible to used for other purposes, such monitoring and managing other kinds of vehicles, thanks to its modular architecture and wireless connection. Overall, the project has given great expertise in complicated engineering system design, implementation, testing, and performance analysis. The study also emphasises the significance of data collection and analysis in the motorsports industry as well as the potential advantages of simple, affordable solutions that can enhance performance and safety.

5. REFERENCES

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