IFERP
connecting engineers... developing research

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)

Vol 8, Issue 8, August 2021

Real time Data Acquisition System for FSAE Vehicle

[1] Atharv Kothe, [2]Sakshi Jadhav, [3]Akalpita Umate, [4]Rishikesh Gurav, [5]Shivam Deshpande, [6]Manas Uplekar

[1][2][3][4] Department of Electronics and Telecommunication, Marathwada Mitra Mandal's College of Engineering, Pune, Maharashtra, India

***Abstract*---The need of the telemetry system for FSAE cars arose with the need to improve the car performance. For this, various factors needed to be monitored like vehicle performance, reliability, safety etc. The telemetry system to be implemented would collect the data from various sensors in a moving car and a Wi-Fi enabled host microcontroller will upload this data on a central dashboard on IoT cloud platform. The real time data can be visualized and accessed remotely This incoming data in the system can be processed and stored for later analysis Based on this data, the necessary changes can be done to enhance the performance of the vehicle. This system not only tracks and inspects the performance but also uses the data to calibrate the geometry of the mechanical systems of the vehicle.**

***Index Terms*— cloud, FSAE, IoT, microcontroller, sensors, telemetry**

I. INTRODUCTION

Data acquisition is the process to monitor and analyze physical and electrical parameters. It is a combination of hardware and software consisting of sensors and actuators, signal conditioning unit, analog to digital converter, controller, and software used to store and visualize the data. There is a marginal difference between data acquisition and telemetry system. Telemetry is an extension of conventional data logging as it does real time monitoring. The data is captured and transmitted from remote places using transmitters or similar kinds of devices. This system is introduced in FSAE vehicles for optimizing its geometry and improving the performance, by collecting the data from physical parameters of a moving car. To overcome the previous year's drawbacks mainly overheating and vibration, real time data was required for analysis. By monitoring the necessary parameters such as temperature and pressure, the possible failures in the system will be indicated and corrective measures could be taken. Being telemetry, this system will allow users to access the data remotely from anywhere and provides data at a faster rate with more accuracy. The designed system is centered around a Wi-Fi enabled controller that will upload the data acquired from different sensors to a cloud platform. This data is displayed on the dashboard using graphical form which makes it easy to understand and analyze.

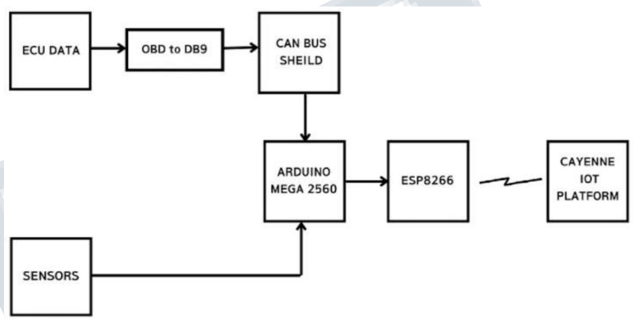

Fig. (1) Block diagram

II. SYSTEM OVERVIEW

The proposed system is intended to gather the information necessary for running the Formula Society of Automotive Engineers vehicle at its peak performance to ensure fuel efficiency, safe driving and to avoid possible damages. Engine Control Unit forms a significant part of a vehicle as it performs important functions such as controlling fuel injection and ignition timings. It receives data from various sensors in the car, extracting this data from ECU such as the signals from coolant temperature sensor, throttle position sensor, manifold absolute pressure sensor is important to avoid any kind of malfunctioning in them. Other safety critical information such as damper compression, vibration, inlet and outlet temperature and RPM, steering angle is gathered by connecting sensors externally. The ECU information is taken from the Onboard Diagnostic (OBD) Data Link Connector near the driver's compartment. Controller Area Network (CAN) Bus shield is used to collect this data via standard OBD to DB9 connector and send to the Arduino Mega microcontroller. The external sensors such as infra-red sensor for Revolution per Minute (RPM) measurement, Linear potentiometers for suspension position, Accelerometer for vibration, hall angle sensor for steering angle, Dallas for temperature measurement etc. are interfaced to the controller. This combined data from ECU and external sensors is transferred from Arduino Mega controller to Wi-Fi module through serial communication. The Wi-Fi module uploads this data to the cloud platform Cayenne where it is visualized in graphical format.

III. HARDWARE DETAILS

A. Sensors

i. RPM Sensor

Fig. (2) E18-D80NK Adjustable Infrared Sensor Switch.

The type of sensor used for reading is the E18-D80NK adjustable proximity type IR sensor. Adjustable refers to a detection range of about 3 – 80 cm, where the detection range can be changed according to requirement. It requires input voltage of 5V DC and consumes current around 300mA which is a plus point as it consumes less current and can be used without worrying about the power consumption factor. It has a digital output pin which can be used to gather information when connected to Arduino so that data can be collected for future analysis. This sensor consists of a set of transmitter and receiver which works as a digital tachometer useful in measurement of speed of any rotating object and so is used for reading RPM.

ii. Temperature Sensor

Fig. (3) Dallas sensor

DS1B20 temperature sensor manufactured by DALLAS Semiconductor functions as a digital thermometer that provides temperature measurement. The sensor measures precise temperature variations to give configurable digital output with 9–12-bit resolution. The sensor consists of built in 12-bit ADC and can be easily integrated with microcontrollers to provide output signals over a single wire. In this design, the sensor is integrated with Arduino Mega to give the information about inlet and outlet temperature.

iii. Vibration sensor

Fig. (4) Accelerometer ADXL335

ADXL335 triple axis accelerometer is used in this design for vibration and shock measurement. An accelerometer is a device to get data about acceleration force, measured in g units. ADXL335 has 5 pins containing 3 analog outputs, Vcc and ground. It gets data about acceleration along multiple axes and supplies analog output proportional to acceleration along them. These analog outputs of the sensor are interfaced with the analog pins of the Arduino Mega. It can be used for sensing the tilts in multiple axes as well as dynamic.
acceleration which is caused due to vibration, shock, and motion.

iv. Steering Angle Sensor

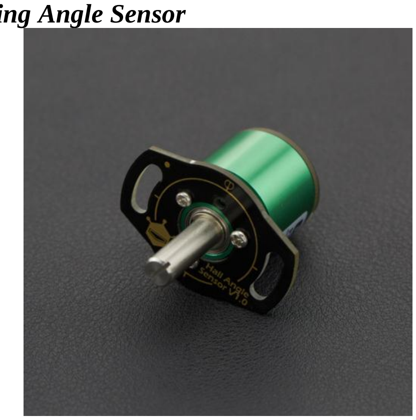

Fig. (5) Gravity Hall Angle Sensor SKU SEN0221

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)

Vol 8, Issue 8, August 2021

A small and robust 360-degree rotary sensor based on the principle of hall effect is used to get the data on angular displacement of the steering wheel. The steering angle information along with other parameters is vital to estimate the driver performance, vehicle dynamics and determine the direction of front wheels. These are usually mounted on the steering rod to get the most accurate measurements. It works on a 5v dc supply, has +- 0.3% full scale accuracy and can be directly interfaced to the Arduino.

v. Linear Potentiometer

Fig. (6) Linear potentiometer

Linear potentiometer is used to measure the displacement along a single axis. The rod of the sensor is connected to the suspension, so as suspension moves the distance covered is converted to proportional voltage. Omega's LP802 linear potentiometer series can measure the displacement of about 150 mm with linearity of 1%FS and sensitivity of 0.00127mm.

B. CAN bus shield

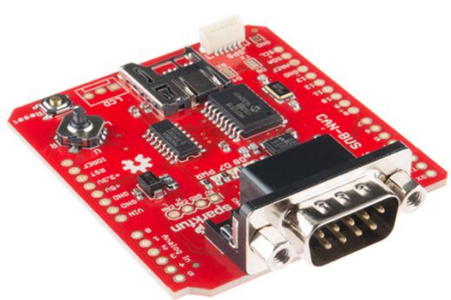

Fig. (7) CAN bus shield

The data from the ECU of the vehicle is taken from a data link connector via OBD2 to DB9 cable. This data is fed to the CAN bus shield. The CAN protocol is used for communication between different electronic devices like ABS system, airbags, power steering and ECU. CAN bus is basically a two-wire communication protocol which allows devices to communicate with each other without any host controller. CAN bus shield which is being used is built around the Microchip MCP2515 CAN controller IC with SPI interface and MCP2551 CAN transceiver. Among these two IC's, MCP2551 is a high speed can transceiver IC which serves as buffer between bus and MCP2515 controller IC. It supports high speed operation of CAN up to 1MB/s. Another IC MCP2515 is used to interface CAN bus with microcontroller unit via SPI (Serial Peripheral Interface) protocol so that the MCU can read and process the data.

C. Wi-Fi module

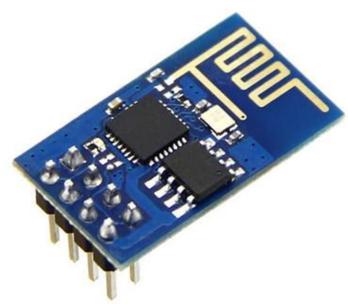

Fig. (8) ESP8266 Wi-Fi module

ESP8266 is a compact and standalone chip manufactured by Espresso Systems that gives this project Wi-Fi accessibility. It works on a communication interface voltage of 3.3V with working current of 240mA. The module consists of 8 pins namely 2 GPIO’s, Tx and Rx for serial communication, chip enable and Reset to configure the chip and supply pins Vcc and Ground. Arduino Mega communicates with ESP8266 over serial communication to transfer the data obtained from sensors. This module connects to a cloud server to upload the data on Cayenne IoT platform.

D. Arduino Mega microcontroller

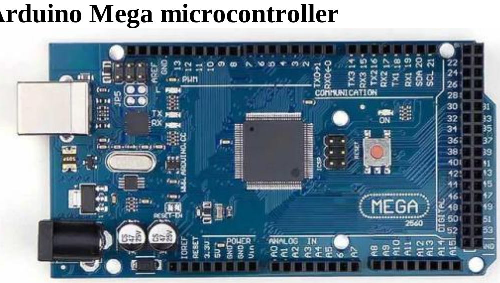

Fig. (9) Arduino AT mega 2560 microcontroller

Arduino Mega 2560 is the brain of the system that collects the entire data from all the sensors and CAN Bus shield to transfer it to the cloud via ESP8266.

ISSN (Online) 2394-6849

International Journal of Engineering Research in Electronics and Communication Engineering (IJERECE)

Vol 8, Issue 8, August 2021

Specifications are as follows:

- Microcontroller - AT mega 2560
- Supply Voltage - 5V
- Digital I/O pins - 54
- Analog I/O pins -16
- Recommended input voltage - (7-12) V
- Clock speed - 16MHz

IV. SOFTWARE

Cayenne

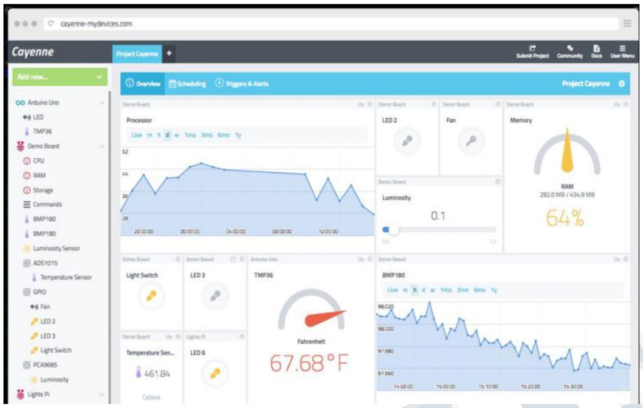

Fig. (10) Cayenne dashboard

Cayenne IoT cloud platform is used for visualization of data in graphical format. In this project, a Wi-Fi module connects to Cayenne and uploads the data obtained from sensors in real time. Cayenne provides an easy-to-use user interface for creating a customizable dashboard. Variety of options for widgets helps the user to monitor almost any type of real time data with graphs. The obtained data can be logged in the forms of time series format and spreadsheets for future references. Cayenne can also be used to control the actuators interfaced to the devices which are connected to it. One of the special features of this platform is that it can schedule the events regarding the system. After a set time, it can generate alerts or send a notification to the user via emails or messages for the scheduled event.

V. CONCLUSION

The presented system will be able to achieve the goal of retrieving live data from sensors. It is a low-cost solution compared to readily available data acquisition systems in the market. This system can be easily fixed by replacing the individual components in case of any damage and can be easily upgraded when necessary. Wi-Fi access and cloud-based data monitoring makes it easy to achieve faster and accurate display of data with smaller delays. Additionally, it can be easily accessed by multiple users from remote locations. The data logged and analyzed over time can be used for making the necessary changes in the design and dynamics to improve the overall performance of the vehicle.

REFERENCES

[1] Steve Corrigan “Introduction to the Controller Area Network (CAN)” Application Report August 2002–Revised May 2016

[2] A. Ghosal, Haibo Zeng, and Marco Di Natale “Understanding and Using the Controller Area Network Communication Protocol: Theory and Practice.” Springer New York, Released January-2012.

[3] DATA ACQUISITION HANDBOOK, A Reference for DAQ And Analog & Digital Signal Conditioning, THIRD EDITION

[4] J. M. Hughes, “Arduino: A Technical Reference",O'Reilly Media, Inc., Released May 2016

[5] Bob Henderson, John Haynes, “OBD-II & Electronic Engine Management Systems”, Haynes Manuals N. America, Incorporated, 2006.

[6] Tom Denton, “Automobile Electrical and Electronic Systems”, Third Edition, 2004.