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Electronic Data Logger and Telemetry

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***Abstract*— The project concerns about setting up of an intelligent data extraction and data analysis system which can be implemented in real time applications to monitor and study the behavioural aspect of the subject at any instant of time and can be brought one step ahead with installation of a facility that would alarm the concerned authority when the subject concerned breaches a predefined limit that has been set by the programmer. For fruitful data acquisition and warehousing we are using an RC NITRO car that would depict the environment of the experimental setup being installed on a real life automobile. Constant examining of important parameters viz., temperature, pressure, G-Force and axial acceleration has been retrieved using MCU unit and wireless counterparts. At the backend these data are accumulated by a processor development board into an SD card that will also simultaneously plot the relevant data accumulated with it using a graphics tool.**

***Index Terms*— Data acquisition, RC nitro engine car, accelerometer, gyroscope, temperature sensor, Arduino Mega, Raspberry Pi, Zigbee, Data analysis.**

I. INTRODUCTION

This project aims for setting up of an environment that does data acquisition of a subject under observation for studying the complete versatility of the same. With this approach the subject is made to perform in all the environmental conditions pushing the limits from very least activeness to extreme pressure on the engine thus studying the real-time dynamics of the engine so as to keep a track of the engine's behaviour also calls for preparedness for any uncertainties that needs to be tackled if anything goes in haywire manner. Hence we are employing sensors that tentatively read the data viz., temperature, pressure, G-force, axial acceleration etc and gives this to a local MCU. This MCU acts as a client for the remote server that lies in the user's custody. The MCU wirelessly sends the data which is timely obtained by the server. The server in turn is a microprocessor based platform that logs the data in a memory. Also this data can be plotted and different characteristics can be studied as per user's

discretion. By setting up of an intelligent data warehousing system like this, the aim of studying any real life situation like studying the thermodynamics of a gas turbine and its parameters at different work stress put forth on it has been accomplished without human intervention as the conditions are not permissible for any human activity to co-exist with the working condition. Thus depicting the actual working background has been well sought and established by this project. Also further ups, we are working on a system that alerts the concerned authorities using the modules for data communication when the expected value breaches the predetermined level of caution, and create immediate alertness among the mitigation forces which is very much needed during bio-hazardous material's exposure to man which in turn sets up an intelligent closed loop system that replaces for all those lacksity due to human nature and everything remains under computer domain which calls for acute flawlessness and untiring workforce at low expense at user's end.

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II. RESOURCES USED

Hardware components used in this project are as following:

1. Arduino MEGA :

Arduino is an open source software development and robotics platform. Here, embodies the AtMega 2560 into its core. It has 256KB flash.10 bit ADC resolution channels.I2C protocol adaptable, SPI programmability is also featured by this board. Four UART(Hardware) ports supported by the same MCU is also available. Can support data rate from 2400 to 115200 bauds.

Figure 1. Arduino Microcontroller Board

2. ZIGBEE PRO SERIES 2B.

This module gives a range on 2miles.
Radiated antenna power of 63mW(+18dB).
With standard data rate of 250Kbps. It uses FHSS technique for avoid the collision as there would be lot more devices using the same frequency band of 2.4GHz. It uses IEEE 802.15.4 protocol for establishing low power PANs.

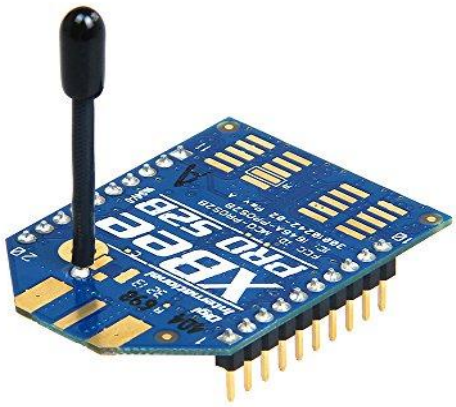

Figure 2. Xbee module

3. MPU6050 :

The InvenSense MPU-6050 sensor contains a MEMS accelerometer and a MEMS gyro in a single chip. It is very accurate, as it contains 16-bits analog to digital conversion hardware for each channel. Therefor it captures the x, y, and z channel at the same time. The sensor uses the I2C-bus to interface with the Arduino.

MEMS Accelerometer range: ±2g, ±4g, ±8g, and ±16g
MEMS Gyroscope range: ±250, ±500, ±1000, and ±2000°/sec

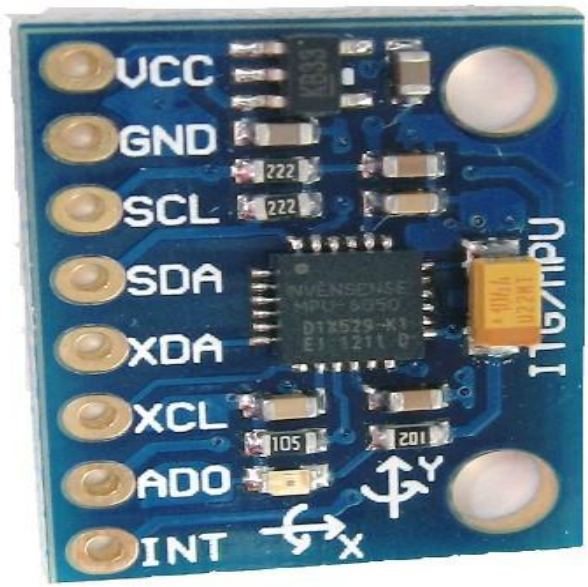

Figure 3. MPU6050

4. USB Adapter for ZigBee

These are USB to FTDI convertor boards with Headers for ZigBee's basement. It also has pins fabricated for Breadboard mounting purposes.

5. Raspberry PI

RaspberryPi is based on the Broadcom BCM2835 system on a chip (SoC), which include an ARM1176JZFS 700 MHz processor, VideoCore IV GPU, and was originally shipped with 256 megabytes of RAM, later upgraded (models B and B+) to 512 MB. The system has Secure Digital(SD) (models A and B) or MicroSD (models A+ and B+) sockets for boot media and persistent storage. The SoC used in the first generation Raspberry Pi is somewhat equivalent to the chip used in older smartphones (such as iPhone / 3G / 3GS). The Raspberry Pi is based on the Broadcom BCM2835 system on a chip (SoC), which includes an 700 MHz ARM1176JZF-S processor, VideoCore IV GPU, and RAM. It has a Level 1 cache of 16 KB and a Level 2 cache of 128 KB. The Level 2 cache is used primarily by the GPU. The SoC is stacked underneath the RAM chip, so only its edge is visible.

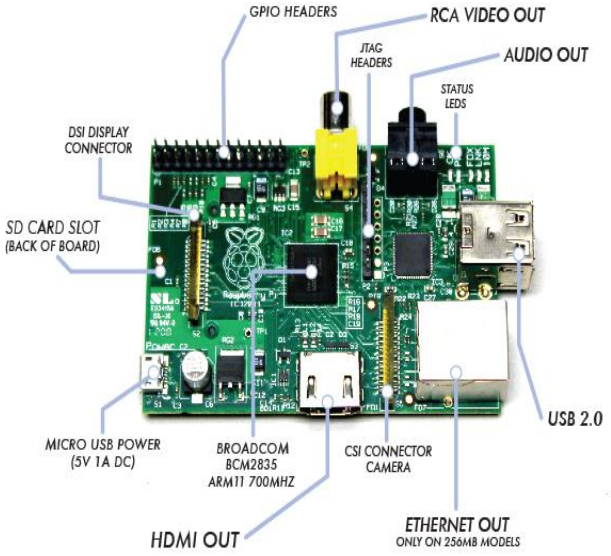

Figure 4. Raspberry pi

6. A1301 Hall effect sensor:

The A1301 is continuous-time, ratiometric, linear Hall-effect sensor IC. They are optimized to accurately provide a voltage output that is proportional to an applied magnetic field. This device has a quiescent output voltage that is 50% of the supply voltage. Output sensitivity option is provided: 2.5 mV/G typical for the A1301. The Hall-effect integrated circuit included in each device includes a Hall circuit, a linear amplifier, and a CMOS Class A output structure. Integrating the Hall circuit and the amplifier on a single chip minimizes many of the problems normally associated with low voltage level analog signals.

Figure 5. Hall Effect Sensor

7. BMP085 barometric pressure and temperature sensor:

Operational specs:
Vin: 3 to 5VDC.
Logic: 3 to 5V compliant.
Pressure sensing range: 300-1100 hPa (9000m to -500m above sea level)
Up to 0.03hPa / 0.25m resolution
-40 to +85°C operational range,
+-2°C temperature accuracy
This is a sensor by BOSCH.
It is an ultra low power device.
It consumes 5uA at 1 sample/second.

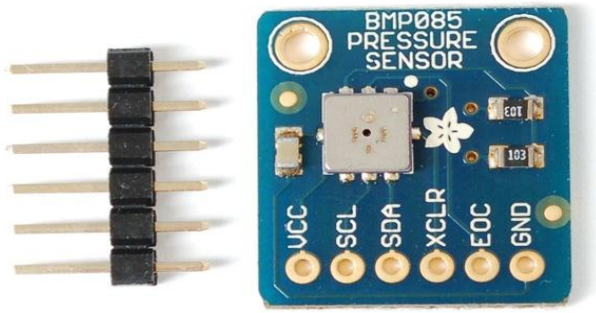

Figure 6. BMP085

III. HARDWARE IMPLEMENTATION

The RC Nitro car is an IC Engine car that uses NitroMethane as the fuel for combustion. The Sensors BMP-085, MPU6050, A1301 Hall effect sensors are mounted on the car's engine cover at different locations. The Arduino Mega is used as a master to supervise and co-ordinate the activities. The Arduino is acquitting the data from these sensors and is sending in the form of a string to the Zigbee modules serially. These modules act as point to pint communication agents and transfer the data from slave arduino to the master Microprocessor development board Raspberry Pi lying with the user. The Raspberry Pi obtains the data from the zigbee module attached to it and then uses any Graphical tool to plot the data in a way easier to interpret and analyze.

IV. SOFTWARE IMPLEMENTATION

Since the Aim is to acquire data about temperature, pressure, G-Force and acceleration. The GY-521(MPU-6050) is connected to arduino via I2C bus lines. The temperature and pressure sensors are also connected in the same method. We are using library for extraction of data from the above said modules. The data from MPU6050 consists of sequential data from the accelerometer as well as the gyroscope. Accelerometers are known for depicting slow variations in data i.e, it provides sluggish response. Gyroscopes are known for reflecting sudden changes in data.
Hence we are using an algorithm that will merge the data from both the modules and give final simple angle information that can be interpreted. This algorithm is called the Kalman Filter algorithm.
Also by reading the raw values from the buffer of the same module will give the raw G-Force value which is normalized by dividing with sensitivity of the module to give Raw G-values in all the three axial directions. The temperature sensor provides the data in the form of string through I2C bus to the arduino which is timely read by using the concerned library functions for interrupt driven data extractions. The accessed data is now formatted to be able to send via wireless means to the mother processing unit. The processed data is sent with identifiers to distinguish the data elements in a stream flow of data loaded timely to the remote CPU. The RC nitro car is particularly used for this project as it can be remotely controlled and depicts the real time use of the same project with automobiles, as its generated heat quotient and jerks in the motion of the car as well as forward acceleration, the net pressure as well as the orientation of the car varies timely which was very much needed for distinguished data interpretation, plotting and simulations sake as well adds to the fruitfulness of the project in the desired manner.
The mother processor at the user's end is constantly accessing the data from the wireless modems and logging it in the SD card. This data is then plotted using visualization tools to see varying nature of the data at the remote end and study the parameters of the target subject.

V. CONCLUSION

We have implemented a system that works as a real time data acquisition device setup such that the Microcontroller as well as the microprocessor work in tandem in a master-slave configuration so as to sense the data from the sensors mounted on the nitro car and then process these data to a substantial level, then making it fit for serial transmission through the wireless support by zigbees and thus leading to a synchronous data transferring and monitoring system that can be tentatively viewed through a graphical plotter application in the Raspberry Pi's desktop window and thus can study different parameters pertaining to the car's engine and its external periphery.

VI. ACKNOWLEDGEMENT

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