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Mobile Wireless Sensor Network Gateway Using Raspberry Pi Implementation with VPN Backend to Openstack

Bhagya[1], Pramila[2], Pooja Prakash[3*], M. Pooja[4]
[1]*Assistant Professor, Department of Electronics and Communication Engineering, East West Institute of Technology, Bengaluru, India*
[2]*Associate Professor, Department of Electronics and Communication Engineering, East West Institute of Technology, Bengaluru, India*
[3,4]*Student, Department of Electronics and Communication Engineering, East West Institute of Technology, Bengaluru, India*
*Corresponding author: poojarachana05@gmail.com

***Abstract*: Internet of Vehicles is an upcoming technology. In our project, we are taking a step towards this On-board diagnostics (OBD) is a simple vehicle self-diagnosing system and has reporting capability. OBD systems give the vehicle owner or repair technician access to the status of the variety of vehicle subsystems. The amount of diagnostic information available via OBD has varied broadly since its introduction in the early 1980s versions of on-board vehicle computers. With the help of OBD II engine parameters like engine oil temperature, engine RPM, throttle position, run time since engine start, engine coolant temperature etc. are monitored.**

***Keywords*: Wireless sensor network.**

1. Introduction

When driving your vehicle, glancing at your dashboard, have you ever thought of collecting the meter readings and do some analysis? These data may contain hidden treasures. For individuals, it can reflect your driving habits, it can tell you your speed, your average mpg, how many traffic lights you have, and your waiting time at each cross. For companies, these data are critical for real-time monitoring in fleet management. Vehicle condition, work load distribution, gasoline efficiency, and even vehicle location can all be fed back to a central control system through cloud. Companies can use machine learning to feed the data into a training model to predict the cost and even analyse the driver's characteristics. As IoT is widely spreading, the above applications won't be far away. With the Raspberry-Pi MKR boards, targeting at IoT applications, you can build a device that talks to your car and uploads telemetric data into cloud all by yourself. Isn't that cool?

Internet of Vehicles is an upcoming technology. In our project, we are taking a step towards this On-board diagnostics (OBD) is a simple vehicle self-diagnosing system and has reporting capability. OBD systems give the vehicle owner or repair technician access to the status of the variety of vehicle subsystems. The amount of diagnostic information available via OBD has varied broadly since its introduction in the early 1980s versions of on-board vehicle computers. With the help of OBD II engine parameters like engine oil temperature, engine RPM, throttle position, run time since engine start, engine coolant temperature etc., are monitored.

The proposed system establishes a connection with OBD of a vehicle and provides vehicular connectivity with Smartphones using internet for the already existing vehicles that don't have an inbuilt vehicular connection, plus add additional sensor units which are not present, making it easy to monitor all the systems in the vehicle. Most vehicles that are on roads don't have this technology and this is mostly found in expensive cars. Using the proposed system, such vehicular connection system can be installed separately at a cheaper expense in all vehicles. Through this, the status of the vehicle is diagnosed by the OBD system and the report is transferred using Wi-Fi to the car owner's smartphone. Using the system, additional sensors can be added to a vehicle to upgrade its functionality, which the system supports. Additionally, driver assist functions are introduced, helping the driver during travel.

2. Block Diagram

The proposed system is based on the microcontroller. Considering the relatively high-performance requirements of image processing in general and the equipment currently available to the faculty, as a relatively inexpensive and powerful embedded platform the Raspberry Pi was an obvious choice and it will display on the LCD screen. Wi-Fi module is a built-in module in Raspberry Pi hence it enables to connect the sensor network to cloud.

The sensor nodes are designed with one or more sensors (i.e., temperature, light, humidity, moisture, pressure, luminosity, proximity, etc.), microcontroller Raspberry Pi, external

memory, analog to digital converter (ADC), antenna and battery. Again, the nodes are limited on-board storage, battery power, processing and radio capacity due to their small size. However, the mobile sensor node architecture is almost similar to the normal sensor node. But some additional units are considered on mobile sensor nodes such as localization/position finders, mobilizer, and power generator.

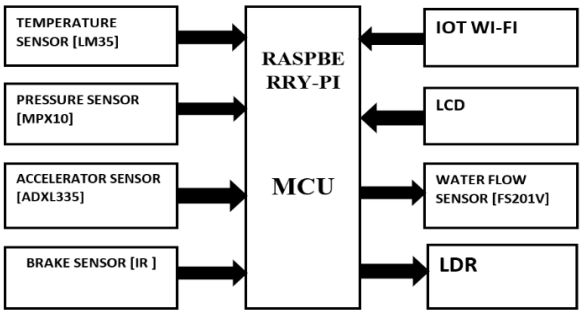

Fig. 1. Block diagram of proposed system

3. Hardware Design

A. *Raspberry Pi model*

Pi is a credit-card sized computer that connects to a computer monitor or TV and uses input devices like keyboard and mouse. It is capable of performing various functionalities such as surveillance system, military applications, surfing internet, playing high definition videos, live games and to make data bases.

It has a 40pin extended GPIO,4 x USB 2 ports, Full size HDMI.

Raspberry Pi is a node which also acts as a gateway between wireless sensor network and the cloud for updating the sensor parameters.

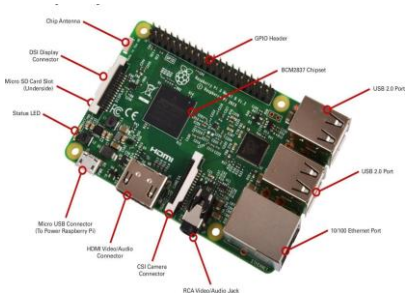

Fig. 2. Raspberry Pi model

B. *MCP3008 ADC*

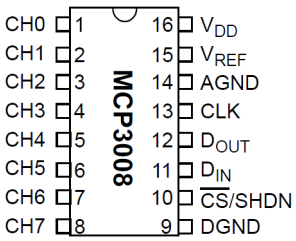

Fig. 3. MCP3008

The sensors sense the parameters in analog form. But, the raspberry pi receives input in digital form hence the sensors are interfaced with and analog to digital converter which converts signals into digital signals. This interfacing will enable the controller to understand and process the sensor parameters to be displayed.

C. *Temperature Sensor*

LM35 Temperature sensor [5] is used to sense the current surrounding temperature as shown in figure 4. It consists of 3 pins in which first pin is VCC, which is connected to 5volts supply in Arduino, second pin is analog output pin, which is connected to A1of analog input/output pin in Arduino & third pin is a ground pin, which is connected to ground in Arduino. It senses the surrounding temperature in the analog form and is given to MCP3008 where it is converted to digital form and displayed in the LCD module. It has an advantage over the linear sensor which calculates in Kelvin, we can get the output in Centigrade scaling directly without any conversions. It can sense from -55° C to 150° C range and ensures 0.5° C accuracy.

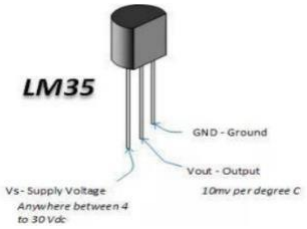

Fig. 4. LM35 Temperature Sensor

D. *FS201V water level sensor*

The water level sensors are used to detect the level of substances that can flow. Such substances include liquids, slurries, granular material and powders. It has high-temperature flow housing.

It has Analog output of range 0V to 5V and
Digital output of I2C.

Fig. 5. Water level sensor

E. *MPX10 pressure sensor*

It is mainly used to check the turbidity which is the measure of thickness. A pressure sensor is a device for pressure measurement of gases or liquids.

Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area.

A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. It's Operating Temperature –40 to +125 °C.

Fig. 6. Pressure sensor

F. ADXL335 Accelerator Sensor

Today's modern cars, trucks and SUVs are all equipped with an electronic throttle control system that contains an accelerator pedal position (APP) sensor.

This sensor's primary job is to monitor the position of the throttle pedal and send an electronic signal to open the throttle body as the gas pedal is depressed.

Acceleration is the measurement of the change in velocity, or speed divided by time. Interface: 3V3/5V microcontroller. Voltage requirement: 3-6V. Output format: Analog output. Measuring range: +_3g

The ADXL335 is a complete 3-axis acceleration measurement system.

Fig. 7. Accelerator sensor

G. Infrared Brake Sensor

Brakes are usually spinning fast when we want to measure their temperature. A normal surface-contact sensor, like a thermocouple, will not work as its wires are likely to become tangled. A wireless transmitter cannot solve the problem either. Because brakes spin and vibrate so quickly, they affect the performance of the electronics inside wireless transmitters. The best solution is therefore to use infra-red sensors which will sense the motion of object.

Fig. 8. Infrared sensor

H. Light Dependent Resistor

An LDR (light dependent resistor), offers the resistance in response to the ambient light. The resistance of the LDR increases as the intensity of light increases. It can act as a sensor, since a varying voltage drop can be obtained in accordance with the varying light.

Fig. 9. LDR

I. (16x2) LCD Display

Liquid Crystal Display (LCD) as shown in figure 6 is an electronic display module. It is most commonly used in embedded papers because of cheap price, availability and provides programmer friendly. The LCD displays 32 characters, in each character there will be 32 crystals for displaying a character. In our day to day life we come across these kinds of displays such as PCO's or calculators. It operates in the range of 4.7V to 5.3V. The temperature sensed from the LM35 sensor is displayed in the LCD module.

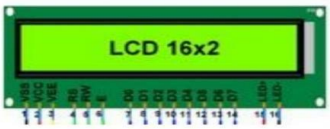

Fig. 10. (16x2) LCD display

J. Abbreviations and Acronyms

4. Open CV

It is a library of programming1functions mainly aimed at real-time1computer vision. It is developed by Intel research Centre and subsequently supported by1Willow Garage and now maintained by itseez. It is written in C++ and its primary interface is also in C++. Its binding is in Python, Java, and Mat lab. OpenCV runs on a variety of platform i.e. Windows, Linux, and MacOS, OpenBSD in desktop and Android, IOS and Blackberry in mobile. It is used in diverse purpose for facial recognition, gesture recognition, object identification, mobile robotics, segmentation etc. It is a combination of OpenCV C++ API and Python language. In our project we are using OpenCV version 2 OpenCV is used to gesture control to open a camera and capture the image. It is also used in the image to text and voice conversion technique.

5. Working Principle

The Raspberry Pi coding is programmed in the following manner. When We Interface analogue sensors with the Raspberry Pi, we would need to be able to measure the resistance of the sensor. Unlike the Arduino, the Raspberry Pi's GPIO pins are unable to measure resistance and can only sense if the voltage supplied to them is above a certain voltage (approximately 2 volts). To overcome this issue, we use an Analog to Digital Converter (ADC) MCP 3008.

The Raspberry Pi will repeatedly display the resistance of the photo resistor. If you place your finger over the photo resistor, the resistance will increase. If you shine a bright light on the photo resistor, the resistance will decrease.

The Microchip MCP3008 ADC is a 10-bit Analog to Digital (A/D) converter with on-board sample and hold circuitry. Communication with the device is accomplished using a simple serial interface compatible with the SPI protocol. The MCP3008 operates over a broad voltage range (2.7V – 5.5V), and low-current design permits operation with typical standby currents of only 5 nA and typical active currents of 320 µA.

As the capacitor gradually charges, the voltage that passes through the circuit and to the GPIO pin rises. Once the capacitor is charged to a certain point, it's voltage rises above 2 volts and the Raspberry Pi will sense that GPIO pin 13 is HIGH. If the resistance of the sensor increases, the capacitor will charge more slowly and the circuit will take more time to reach 2 volts. The digital signals are transmitted to the controller from where the information will be stored in cloud. It is due to the application of IoT the information stored in cloud the user can receive the message. These messages are received through the cloud-based SMS system called TWILIO.

Fig. 11. Flow diagram of proposed system

6. Results

As per the result, the extreme conditions of different functionalities of the vehicle are detected. This specifies that the system has the capacity to detect or sense any physical changes in the vehicle and convert them into corresponding electrical signal with the help of sensors. The analog signal sent by sensor is converted into digital signal using MCP3008 analog to digital converter. The digital signals are transmitted to the controller from where the information will be stored in cloud. It is due to the application of IoT the information stored in cloud the user can receive the message. These messages are received through the cloud-based SMS system called TWILIO.

Fig. 12. Result of MWSNG

7. Conclusion

The possibility to migrate a complete vehicular sub network to a IoT network solution even with a very conservative approach, by just using a microcontroller reducing the sizing of the target system. The higher data throughput and lower energy consumption of the Wi-Fi when compared to an existing system. A Raspberry Pi device, acting as Compute Node in a private cloud proved to be a feasible solution to act as gateway in a mobile wireless sensor network and to provide seamless connectivity over various access technologies

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