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On-Board Vehicle Fault Monitoring System

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Abstract: The paper proposes a user-friendly cloud-based data acquisition and analytics system for vehicle diagnostic monitoring in real time. The vehicle's condition is assessed using the On-board diagnostics (OBD) framework and the report is sent to the mobile of the driver via Wi-Fi on detection of unsafe and anomalous events in real time. Vehicle parameter values are instantaneously uploaded to the server. The smartphone app also visualizes data from the sensor and also generates warnings in real time. It establishes a vehicle's OBD connection and provides communication with mobile using the internet for vehicles that don't have a facility of an integrated vehicle interface. With the system, external sensors can be attached to a vehicle to enhance its performance. Most of the vehicles on the roads do not have this infrastructure and this is often seen in luxury automobiles. This vehicle communication system can be mounted on all vehicles independently, utilizing the proposed system at a cheaper cost.

Keywords: Automobile; OBD; Microcontroller; Internet of things (IoT); Smartphone; Cloud-based server

I. INTRODUCTION

Automobiles are ensuring with drive, passenger comfort and safety controls. Such controls include a braking system, the steering wheel, a gear shift, ventilation, lights and other functions. Modern controls for vehicles, for example accelerator and brake spot, are now universal, but this has not always been the condition. Controls change in reaction to emerging developments, such as mobile communications convergence [1]. IoT requires the ability to transmit knowledge over a network, without involving user to user or person to computer contact. This infrastructure involves inter-related electronic systems, mechanical and automated equipment [2]. This paper illustrates the design of IoT framework development for the OBD system on non-OBD vehicles.

II. LITERATURE SURVEY

D. S. Yun et.al suggested a wireless sensor network framework for vehicles that applies wireless sensor network technologies. It includes a base-station for vehicle wireless, wireless sensor nodes for vehicles and an OBD module. The base station collects information from the Electronics Control Unit (ECU) collected from the OBD module. This+ module is in-turn connected to the OBD port available within the vehicle that collects information of ECU via in-vehicle network like Controller Area Network (CAN). The base station receives and processes the sensor information obtained from each node. Eventually, the information on the ECU and the sensor should be transmitted to the smartphone and delivered to the vehicle driver [3].

A CAN bus port was used to connect Arduino Mega2560 with a car ECU. It uses the CAN controller MCP2515 Microchip with the CAN transceiver MCP2551. The Arduino and a Raspberry Pi collect data from the ECU-connected sensor systems. An app is used in the Mobile. The app software is designed to suit the Internet Protocol address of the Wi-Fi module connected to the Raspberry Pi. On an app-installed phone, the driver can track the vehicle machine state. For driver help, the Raspberry Pi is linked by a GPS board, a rear camera and an LCD display for a user interface [4].

Advanced CAN network system, GPS, 3.5G cellular network, and integrated method to develop smart communication for real-time automotive diagnosis and early fault detection is described in [5]. This proposed unit consist of a Vehicle Diagnostics Server (VDS) and on-board unit (OBU). Information of the CAN, position of the vehicle and other real time values are sent through mobile 3.5G to the VDS. The VDS built-in expertise model will then evaluate these vehicle data and provides an early warning of real-time vehicle diagnosis or fault.

M. A. Al-Taee describes a centralized network that provides remote control of the vehicle's location and evaluation of vehicles using GPS / GPRS [6]. Th`e framework provides highly stable and precise vehicle parameter when it pre-programmed with the permitted speed limits, within supervision. The transmitted parameters that are stored for a configurable period on the server memory will serve multiple purposes, such as monitoring movements of stolen vehicles, automated crash warning, incident investigations. But it will not warn the driver or interrupt the car when the vehicle's parameters are in an irregular range.

The automobiles have OBD kits and GSM connectivity systems. Vehicles equipped with ECU are accessible from a remote site, and also the response of the ECU can be routed back to remote server. Server will then identify the issue and submit the rectification instructions. However, the concept has some disadvantages, including practical challenges such as system reliability and scaling factor of data transfer rate for various vehicles. The process is tedious too, and time consuming as discussed in [7].

An IoT-based automotive control system is described in [8]. The OBD scanning tool gathers vehicle details from the vehicle's OBD-II terminal, and the Raspberry Pi uploads it via cellular network to cloud server. The online details and accumulated data maintained on a cloud-based archive are then retrieved through the monitoring system. The application can provide both graphical and concise reporting of data. Through conducting an electronic program on their smartphones and laptops, one can access the data electronically. It also suggests an algorithm for detecting faults in engine cooling systems.

From the above survey, we concluded that in some cases the driver was unable to identify when the fault has been occurred also scan tool is required for OBD-II kits which is expensive. Additionally, it requires a technician who can diagnose faults. The solution is discussed in upcoming sections.

III. METHODOLOGY

The system consists of ARM LPC2148 microcontroller, OBD port, different sensors, Wi-Fi module, a mobile notification app running on a smart phone, and a cloud-based backend. Multiple ECU's are connected to the various parts of the vehicle and sensors are attached to these ECU's for tracking. All ECU's are connected to the server; the ECU's collect values, using mobile phone. Parameters such as oil level, batter status, exhaust gas, throttle position can be viewed by the user in real time. So, when driving the individual knows the vehicle's state and efficiency.

This model fits the architecture of the server-client, since cloud is the server as shown in Fig 1. The network consists of an Android-based mobile smart phone with built-in GPS, a SIM card with internet facility, and the app. All the sensors are connected to the internet through the Node MCU Wi-Fi module ESP8266 which serves as the internet gateway with the aid of web server coding and online hosting. Sensors collect diverse environmental conditions and transfer them to the micro-controller which separately process the data transmitted by each sensor and then send the data collected to the web server at the same time. For potential data processing, system is programmed in such a way that all sensor data are logged per second. The user can access the reading of each sensor while driving through the app installed in a mobile. A control room is also created which uses this database. An official individual can track all parameters simultaneously from one location (control room) via web-server without connecting any physical wire between the control room and device. The proposed prototype is described in Fig 2.

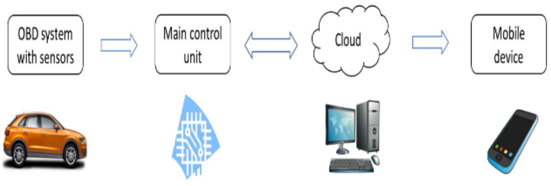

Fig 1. System's overall architecture

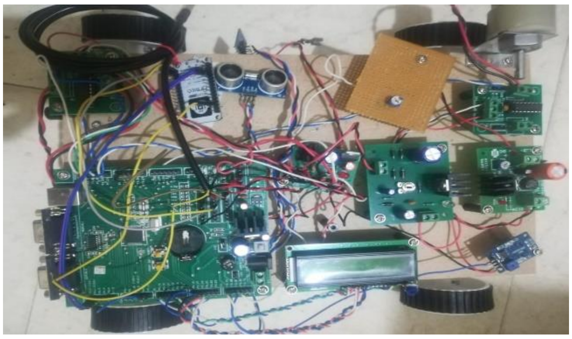

Fig 2. Overview of proposed prototype

IV. RESULTS AND ANALYSIS

A. *Battery status*

In off condition, the battery terminals of vehicle must have 12 to 12.5 volts. The voltage of the terminals will range from 13 to 15 volts, when the engine is on. Caution is issued when the voltage values falls less than those indicated above. The battery status in on condition is shown in Fig 3. The system advises the driver to switch off the engine.

Fig 3. Battery status

B. *Oil level*

Alert will be created when the amount of fuel falls less than 1 liter, or when there is quick diminution in fuel level due to fuel leakage as shown in Fig 4.

Fig 4. Low oil level indication

C. Throttle position

Throttle position sensor ADXL337 is used to monitor the vehicle's throttle for traction monitoring. On abnormal position of the throttle, warning is generated as indicated in Fig 5 and the system recommends the driver to turn off the vehicle.

Fig 5. Abnormal throttle position indication

D. Exhaust gas

Gas sensor MQ2 is used to estimate the content of exhaust gas emitted by vehicle in parts per million. On an event, LCD shows 80% of maximum exhaust gas allowable as it is shown in Fig 6.

Fig 6. Exhaust gas indication

V. FUTURE SCOPE

Today, one innovation used in many cars is a chance to see how economical the driving style is in real time. That is possible due to the right sensor combination. It would be easy to implement this function, but it could be improved by using more sensors and creating data on the driving types. A rule framework can incorporate additional sensors to boost accuracy. This will allow engine tuner to establish more precise situations that they would want to track.

VI. CONCLUSION

This design is suggested primarily for vehicles having no OBD facilities. A strong focus was put on maintaining the device's safety and usability in the car. The model has its own benefits, when compared to the OBDs available in the industries. The parameters are continuously sent to control room, where an official monitor the database and assists the driver if required. The system can be improved by incorporating more sensor. This is quickly achieved because the used local controllers can control further parameters.

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