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A Review on Remotely Monitoring a Car to Improve its Occupant Safety

Rohan R. Patil[1], Makarand N. Kakatkar[2]

Post Graduate Student, Dept of Electronics and Telecommunication Engineering, Sinhgad College of Engineering, Pune, India [1]

Professor, Dept of Electronics and Telecommunication Engineering, Sinhgad College of Engineering, Pune, India [2]

Abstract: One prefers a car for safe transfer to one's destination at low cost, with comfort and predictable travel outcome. IoV (Internet of Vehicles) trends have led to many innovations in cars. This review paper presents a new data collection and calibration platform based on existing network infrastructure, Internet, to collect real-time data of vehicles remotely. The in-vehicle device is used to collect real-time OBD (on-board diagnostics) data and monitor other important parameters like alcohol intoxication of driver and seat-belt status that need to be monitored. This information is then received by the central server. The server sends back instructions or alert messages to alert the admin person. This provides information on driving pattern, control strategy, driving cycle, fault and reliability. Minicomputer Raspberry Pi is used as in-vehicle device and programming is done using Python language.

Keywords: alcohol intoxication, internet of vehicles, on-board diagnostics, raspberry pi.

I. INTRODUCTION

A car has become an integral part of a modern family and is no more just a luxurious belonging of a person. Their usage all over the world has drastically increased during the last decade. This rapid increase has led to many concerns about reckless driving, condition of the vehicle and driver anomalies. Nowadays, people expect more than just vehicle quality and reliability. With rapid development of information and communication technologies (ICT), equipping automobiles with wireless communication capabilities is expected to be the frontier for automotive revolution. Connected vehicles refer to the wireless connectivity enabled vehicles that can communicate with their internal and external environments. These interactions provide passengers with an information-rich travel environment and enhance the situational awareness of vehicles.

Connected vehicles are considered to be the building blocks of the emerging Internet of Vehicles (IoV), a dynamic mobile communication system that features sharing, gathering, computing, processing, and secure release of information that enables the evolution to the next generation Intelligent Transportation Systems (ITS).
With increasing intelligence, modern vehicles are equipped with more and more sensors, such as sensors for monitoring water temperature in the cooling system and tire pressure, sensors for detecting road conditions and driver's fatigue, and advanced sensors for autonomous control. This number is forecasted to reach as many as 200 per vehicle by 2020. Such a big quantity of sensing elements is required to report time-driven or event-driven messages to the electrical control units (ECU) and receive feedback if necessary. In an attempt to improve the passenger safety and to reduce pollution caused, proposed here is a design of an in-vehicle device that captures necessary data and transmits it to the central server. The server sends back alert messages or necessary instructions to alert the admin person. OBD, which stands for On-Board Diagnostics could simply be described as a standard that allows accessing the status of sensors of a vehicle via a port, commonly referred to as the OBD port, where a few of those sensors can be stated as coolant temperature, speed, engine rpm, oxygen and fuel rate. OBD-II, is latest version of OBD and is implemented in most of the vehicles which are manufactured lately. Several adapters of such type are commercially available to read data from the OBD port. ELM-327, which is used in the proposed system is one such adapter where the data which are read from the port are transmitted for further processing via USB cable.[5]

This review paper uses a Wifi USB module with Raspberry Pi to transmit the obtained OBD data and other mentioned parameters to the central server. The data are stored on the server for further processing, if required. Additionally, the driver and the admin person are alerted of violations, if any, through SMS/blinking of LEDs.

II. SYSTEM DESIGN

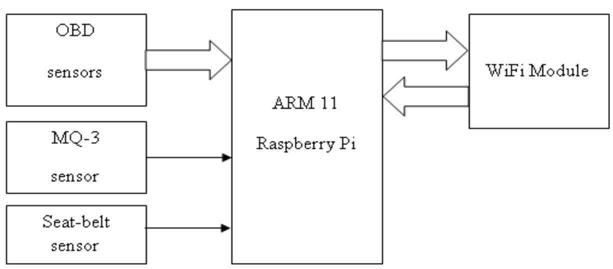

Fig. 1. Block diagram of the system

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The system design using Raspberry Pi with the use of different sensors to monitor OBD data and other important parameters is as shown in Fig. 1. It consists of different peripherals like alcohol sensor (MQ-3 sensor), seat belt sensor (press button switch), set of OBD sensors (USB OBD scanner), Raspberry Pi, and a Wifi module (Mini USB Wifi network card).

The alcohol sensor is an analog sensor and hence needs to be passed through an ADC (analog-to-digital converter) before feeding its values to Raspberry Pi, as Raspberry Pi has no inbuilt ADC. We need to connect an external ADC, in this case MCP3008 (10-bit, 8-channel) for conversion purposes. Channel 0 is used to interface alcohol sensor with Raspberry Pi. SPI-bus communication is used where the role of master is performed by Raspberry Pi and that of slave by ADC.

Seat-belt sensor is realized using a press-button switch. It is connected directly to Raspberry Pi's (BOARD pin number 7) GPIO. The USB OBD-II adapter is directly connected to Raspberry Pi's USB port. The required data can be requested by sending proper PIDs (Parameter IDs). This data is obtained serially by Raspberry Pi at port USB0.

All this information obtained is displayed on a HUD (head-up display) connected to the HDMI port of Raspberry Pi. The data is also sent to the central server with the help of Wifi module (COMFAST CF-WU720N) connected to a Wifi hotspot (e.g. Drive-Thru Internet).

III. RELATED WORK

A number of projects have arisen in the last few years in the field of OBD-II loggers. Most of these have been Arduino/Raspberry-Pi based, which allows for programmable automation.

Dwipjoy Sarkar, and Atanu Chowdhury, in "A Real Time Embedded System Application for Driver Drowsiness and Alcoholic Intoxication Detection", proposed a system which was realized with Raspberry Pi loaded with Raspbian OS, which performed some task like issuing the alarm notification upon receiving the positive detection message. In this project a distinct system was designed which combined the application of computer vision with embedded systems and was targeted for reducing road accidents due to driver drowsiness and alcoholic intoxication.[1]

Zhuang Ji-Hui, Xie Hui and Yan Ying, in "Research and Development of Electric Vehicle Data Collection and Calibration Platform Based on GPRS and INTERNET", presented a new data collection and calibration platform based on GPRS and Internet to collect the driving data of electric vehicles remotely. The platform adopted an in-vehicle device to acquire driving data of electric vehicle and communicate wirelessly with central server by GPRS network and Internet. The platform is applicable to electric vehicles and designed function is of vital importance to calibration and fault diagnostic.[2]

Qinqin Wang, Zhiqui Lei, and Shaocheng Qu, in "Design of Car Remote Monitoring System Based on Internet", introduced a design of car remote-monitoring system based on internet which can realize internet remote control, and draw the trajectories of the car through collecting the data by sensors. It has a good market prospect for the design of the monitoring objects. With the assistance of remote monitoring systems, they have not only overseen the movement of the car, but also intervened when necessary and controlled it in order to complete new tasks.[3]

HaiXin Wang, and Tian Yuan, in "Research on Movement-Based Dynamic Location Management Scheme in Internet of Vehicle", proposed a movement based dynamic location management strategy in location management of vehicle network. Movement based dynamic location management scheme which was proposed in this paper can greatly reduce the required node location update cost. It also helped eliminate the Ping-Pong effect in a certain extent, reduce network congestion, and had good operability. They also proved that the method they presented is superior to the traditional static location management strategy.[4]

IV. HARDWARE USED

The main components of the system include MQ-3 sensor, OBD scanner, Raspberry Pi, Wifi module etc. Brief descriptions of each are as follows.

A. MQ-3 sensor

This analog-gas sensor is suitable for detecting alcohol. It can be used in a Breathalyzer. It has small sensitivity to Benzine and high sensitivity to alcohol. The sensitivity can be adjusted with the help of a potentiometer. Sensitive material of this sensor is SnO_2, which has lower conductivity in clean air. When alcohol gas exists in its vicinity, the sensor's conductivity increases along with the gas concentration rising. This sensor has good resistance to disturb of smoke, gasoline and vapour. The sensor could be used to distinguish between different concentrations of alcohol. It is cheap and suitable for different applications.

B. OBD scanner

These sensors provide real-time measurements (e.g. speed 32kmph). Statuses and readiness monitors provide current status and test results are measured by the vehicle's onboard computer against internal pass/fail values. Different live data parameters include Air Fuel Ratio, Average Economy, Battery Voltage, Boost Pressure, Distance Travelled, Drive Time, Fuel Used, Idle time, Idle percent, Catalyst Monitoring Status and many more.

C. Raspberry Pi

The Raspberry Pi is a series of credit card-sized single-board computers. It is a low-cost micro-computer that was originally intended to help spur interest in computing among school-aged children. It is contained on a single circuit board and features ports for USB 2.0, HDMI, Composite video, Analog audio, Power, SD card and

Internet. These boards are ARM-based micro-computers having 40 GPIO pins and can be programmed in programs such as Python.

D. Wifi module

This module is used to connect the Raspberry Pi with the Internet so that it can send & receive data. It provides high-speed and unrivalled wireless performance.

V. PROGRAMMING LANGUAGES USED

Programming language used here is Python. It is powerful, fast and friendly. It is widely used as it is freely available and makes solving a computer problem almost as easy as writing out one's thoughts about the solution. Its syntax emphasizes readability and therefore reduces the cost of program maintenance. It even helps programmers to express concepts in fewer lines of code. One of Python's greatest strengths is it has a large standard library, providing tools suited to many tasks. It is said to be relatively easy to learn and portable, meaning its statements can be interpreted in a number of operating systems.

VI. CONCLUSION

In-vehicle device is used for collecting driving data and monitoring sub-system of the vehicle. Due to communication distance, Internet is a better choice of driving data collection in vehicle. Using Internet, the in-vehicle device is able to exchange data between the vehicle and the central server, thus realizing remote monitoring, tracking and the analysis of fault. Raspberry Pi is the most suitable processor for this application as it occupies very less space and is also cheap. With a processing speed of 900MHz and 1GB RAM, it is possible to implement this type of system. Interfacing of analog sensors to Raspberry Pi is realized with the help of an external ADC MCP3008. A mini USB Wifi network card interfaced with Raspberry Pi is used to directly transfer sensor data to the central server. Python language is used for programming purpose and the operating system used for Raspberry Pi is Raspbian. The research is still in continuation to develop it into a full blown system. There is much yet to improve and work on in this field.

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