OBD - II based Intelligent Vehicular Diagnostic System using IoT

Siddhanta Kumar Singh, Ajay Kumar Singh, Anand Sharma

Mody University of Science and Technology, Lakshmangarh, Sikar, Rajasthan, India

Abstract

The Internet of Things (IoT) is a the most recent trend of Internet technology which is turning vehicles into the group of an entire ecosystem of connected IoT services. IoT in the vehicular sector offers a new experience for the drivers as provides enhanced safety and security, and a new range of product offerings. Identifying the potentially risky behaviors of driving is the most important roles in avoiding dangerous traffic situations. IoT based systems are now used for vehicle and fleet tracking, fault and error detection, analyzing driver behavior and many other operational needs. The IoT protocols allow us monitoring and controlling remotely, over an existing network which results in improving accuracy, efficiency and security of the system. This paper describes the developments and evolution of Internet of Things in the automotive sector to provide diagnostic system which is intelligent diagnostic system based on IoT.

Keywords

IoT, Vehicular diagnostic system, OBD, CAN., ECU, pyOBD, DTC

1. Introduction

The road accident rate on Indian roads is increasing day by day and hence it's still a main problem in many countries including India. According to the release of government of India, the statistics for accidents on roads, injuries and fatalities [1] due to accidents for the year 2017, and the news continues to worsen year after year. According to the latest data published, there were total of 4,64,910 road accidents in India causing 1,47,913 deaths and 4,70,975 injuries, which means 405 deaths and 1,290 injuries per day from 1,274 accidents[2]. In other words, it also means that there are 16 people who are killed and 53 people who are injured every hour on Indian roads. These are the official report of accidents which is published, but there are number of accidents that go unreported across the length and breadth of the country. There could be many factors for transportation accidents, such as internal problem of the vehicle as well.

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EMAIL: singhsiddhant@yahoo.com (S.K.Singh); anand_glee@yahoo.co.in (A. Sharma)
ORCID: 0000-0002-3578-2730 (S.K.Singh); 0000-0002-9995-6226 (A. Sharma)

To solve these faults, OBD-II [3] is used to diagnose the vehicle's various conditions. It connects the ODB-II with the CAN bus and with smartphone via Bluetooth.

The CAN bus [4] is known as Controller Area Network bus which is the internal LAN in a vehicle system. The external system needs to collect the relevant data from internal CAN in car. In the proposed work, the OBD-II interfaces between internal CAN and external networks. The CAN is a protocol in the specification of OBD-II, and it has been made mandatory for all 2008 and later models of cars.

2. Vehicular Diagnostic System

The Vehicular diagnostic system can monitor various vehicular data like vehicle RPM, oxygen, speed, and engine temperature, coolant etc. in real time. Monitoring these data can efficiently decrease the risk of major accidents on the road. Moreover, the Vehicular diagnostic system also shows exact location of vehicles using GPS location and shows the date and time which can effectively help to find the stolen vehicles.

OBD-II reader is inserted into the car's OBD-II Data Link Connector. The OBD II transmits the diagnostic data via Bluetooth to

the RaspBerry Pi computer. The Vehicular diagnostic system enables car's driver to diagnose the faults in vehicles and if there is any faults detected in the vehicle by the ECU[5] Unit, the application immediately informs the problem to driver, so that they can fix the problem for car safely.

Today almost all the cars and light trucks use On-Board Diagnostic (OBD II) systems. In earlier times, the manufacturers were using electronics methods to control the various functions of engine and diagnose the various engine problems.

This was mainly used to meet EPA emission norms. OBD-II standard has become more sophisticated in the recent years. And as a result of which a new standard was introduced in the mid-'90s, which shows almost all controls of engine and monitors different parts of the body, and other accessories, and diagnose the network of the vehicle.

Now the cars which are manufactured after 1st January, 1996 must have the OBD-II port fitted in it. So the car manufacturers have started incorporating OBD-II connector under dashboard of steering wheel in all the car models. Many of the cars which were manufactured earlier are not 100% compliant to OBD-II.

3. Internet of Things (IoT)

The term Internet of Things (IoT) was first time given by an English pioneer in technology Kevin Ashton who worked on RFID for system of ubiquitous sensors connecting devices to the Internet.

The Internet of Things (IoT) is defined as a network of physical objects known as "things" which are embedded with software, hardware, network, and sensors to share data.

Internet of Things (IoT) combines two terms internet and things. Internet is a network which connects millions of nodes with internet protocols.

The term things in IoT means the smart objects in the network. In the following Figure 1 [6], different objects are embedded with software, network, sensors are connected to each other for communicating data with one another over the internet.

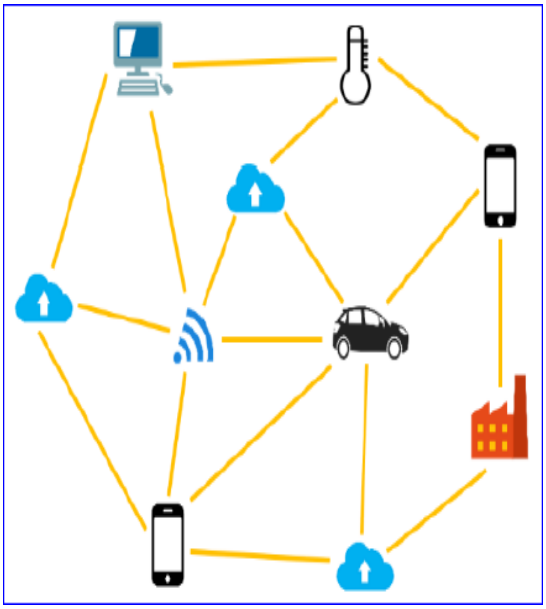

Figure 1: Basic IoT architecture

The goal of IoT is to extend internet connectivity and makes virtually everything smart. The IOT devices like smart watches, smartphone, TV, Washing Machine help us to communicate with the IOT platform.

The fundamental parts of an IOT systems are Sensors, Connectivity, Data processing and user interface. There are four main IoT Protocols. These are MQTT, CoAP, AMQP, and DDS. CoAP stands for Constrained Application Protocol. It is mainly used for systems which are based on http protocols. CoAP uses the UDP for lightweight implementation. Message Queue Telemetry Transport Protocol (MQTT) is basically a messaging protocol. It provides a simple method to distribute telemetry information in IoT systems.

This protocol uses a publish/subscribe communication for the machine to machine (M2M) communication. Advanced Message Queuing Protocol, for short AMQP, is an asynchronous messaging protocol and open source. AMQP provides encrypted messaging between organizations and applications.

This protocol is used in client/server messaging. Data Distribution Service (DDS) is an Object Management Group standard and is used for real-time systems for data communication between the nodes of a publish/subscribe-based messaging architecture.

4. IoT for Vehicular Diagnostic System

The Diagnostic Trouble Codes (DTC) are the sequence of alphanumeric character string which is saved in the memory of ECU computer system. If the engine detects any fault in the component or system which is not working properly, the vehicle immediately stores the relevant DTC code in it's memory.

The code would help one to locate the fault and fix them later. The Diagnostic Trouble Codes may vary from one manufacturer to other. DTC Codes are used with the service manual of the vehicle's to find which part of the unit, circuits or components should be diagnosed for fault. Each trouble code is a string of five characters, out of which the first one is a letter and the rest are four digits such as P1243. There are four categories of OBD II DTC Codes [7].

Body (B-codes): This category of DTC codes includes all the functions which are related to the passenger's compartment. It provides the driver with various parameters related to assistance, comfort, convenience, and safety.

Chassis (C-codes): This type of DTC codes includes all the functions which are related to external to the passenger compartment. This category of DTC codes generally includes information about suspension, brakes, steering etc.

Powertrain (P-codes): This category of DTC codes includes all the functions related to the transmission, engine and associated drivetrain accessories

Network & Vehicle Integration (U-codes): This type of DTC codes includes all the functions which are common to computers and systems in the car. The leftmost character of the DTC code marks trouble codes related to the system.

The OBD-II reader connects to the OBD II port and reads the diagnostic trouble codes(DTC) from the cars memory unit. The OBD-II reader has the standard pin out system.The standardized pin out [3] is shown in Figure 2.

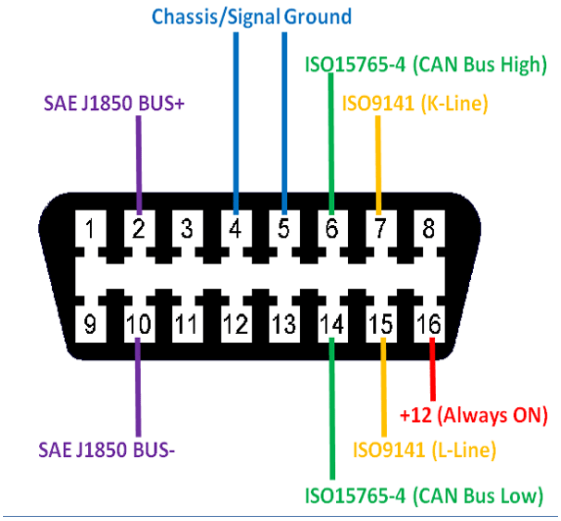

Figure 2: Pin out diagram

Pin 1: Manufacturer based
Pin 2: SAE J1850 PWM and VPW
Pin 3: Manufacturer based
Pin 4: GND
Pin 5: GND
Pin 6: ISO 15765-4 CAN
Pin 7: K-Line of ISO 9141-2 and ISO 14230-4
Pin 10:SAE J1850 PWM
Pin 14:ISO 15765-4 CAN
Pin 15: K-Line of ISO 9141-2 and ISO 14230-4
Pin 16: Power

5. Proposed Model

This section discusses the proposed model for the intelligence vehicular diagnostic system based on IoT as shown in Figure 3.

We use Nano Bluetooth Dongle to connect to Raspberry Pi as in Figure 4 having the Raspbian OS. Raspberry pi is used to process data. For this we download the pyOBD which is available for free. It is an OBD-II compliant that is written completely in Python language. It is used to interact with OBD-II scanner. It allows the programmer to interface with the vehicle's ECU and display the various trouble codes and process according to the fault codes.

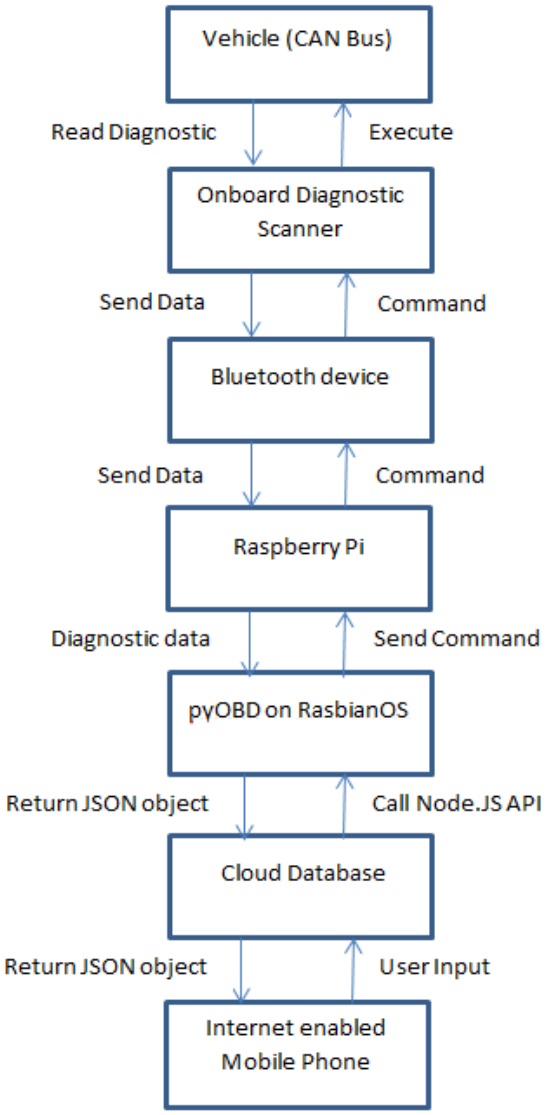

Figure 3: Proposed Model for IoT based Vehicular diagnostic system

Figure 4: Raspberry Pi

Description of OBD II DTC code sequence

$X_5X_4X_3X_2X_1$
X_2X_1 : Fault Detection

X_3 :
1 - Fuel and Air metering
2 – Fuel and Air Metering(injector circuit)
3 – Ignition system or Misfire
4 – Auxiliary Emission Controls
5 – Vehicle Speed Control and Idle Control System
6 – Computer output Circuit
7 – Transmission
8 – Transmission
X_4 :
0 – Generic OBD Code
1–Vehicle Manufacturer Special Code
X_5:
B – Body Code(A/C and Air Bag)
C – Chasis Code(ABS)
P – Powertrain Code(engine and transmission)
U – Network Code(wiring/nus)

6. Working of Proposed Model

The iSaddle OBD II Bluetooth scanner shown in Figure 5 collects the vehicular diagnostic data and are sent via Bluetooth to Raspberry Pi.

The pyOBD is software which is an open source OBD-II (SAE-J1979) compliant written in Python language. It is used to interface ELM-USB. It allows us to communicate to the ECU of our car and display the fault codes and measured values, read various status etc.

Figure 5: Bluetooth Scanner

The pyOBD presents us an interface with data on the basis of OBD-II DTC codes once the diagnostics data is sent to Raspberry Pi.

We are using Node.JS as the server-side language to process the diagnostics data

collected by OBD II from ECU. The Node.JS is a server side programming language which works more efficiently than the traditional PHP. And then this data is encapsulated to JSON [8] Objects and later it is saved to MongoDB[9]. Because MongoDB provides better flexibility for development process and it easily copies databases from one server to another. The JSON Objects which are saved in MongoDB are parsed to user's smartphone by connecting to the internet, Users shall feed their command in the app. Node.JS API processes the JSON objects into ELM-USB list of commands and these command lists are transmitted to the OBD-II device. Finally it triggers the car to execute the commands from the users.

We can reduce response size[10] and increase the performance by reducing the size of response message for a specific PID sent to ECU. For example for Speed, the request message is 01 0D. While sending Request message, our system remembers the PID value.

The first parameter of the response message is fixed and the second parameter was stored in buffer which will be used later to identify this request. Then the system removes these two parameters from response message and sends only the relevant data. Hence data load is reduced and increases the response time. For the request message 01 0D, the response message: 32(H) for Speed instead of 41 0D 32

7. Conclusion

This intelligent vehicular system for driving safety of vehicle is proposed in the paper. This system can achieve safe driving on roads to decrease the major road accidents rate in India.

The system proposes how to study and analyze the DTC data from vehicle and process using Raspberry Pi. It is encouraged to use Raspberry Pi as it provides better feature with inbuilt ports and higher memory. Drivers can send a command to the vehicle using this proposed system.

Raspberry Pi is more suitable because it can be used in multitasking. Also it is advised to use OBD-II device to interface with police and transport department for vehicular safety in the future related to OBD-II scanner.

8. References

[1] https://opsimathdiary.com/2018/01/15/design-of-road-accidents-in-india-the-analysis-of-a-million-deaths/, 2018

[2] https://www.autocarindia.com/industry/road-accidents-in-india-claim-more-than-14-lakh-lives-in-2017-410111.

[3] Emir Husni, Galuh Boy Hertantyo, Daniel Wahyu Wicakson, Faisal Candrasyah Hasibuan, Andri Ulus Rahayu, Muhamad Agus Triawan, Applied Internet of Things: Car Monitoring System using IBM BlueMix, International Seminar on Intelligent Technology and Its Application, 2016

[4] Shahu N Chikhale, "Automobile Design and Implementation of CAN bus Protocol-A Review", IJRDO - Journal of Electrical and Electronics Engineering, ISSN: 2456-6055, VOL 4 NO 1 (2018)

[5] Gabriel Signoretti, Marianne Silva, Alexandre Dias, Ivanovitch Silva, Diego Silva, Paolo Ferrari, Performance Evaluation of an Edge OBD-II Device for Industry 4.0, II Workshop on Metrology for Industry 4.0 and IoT (MetroInd4.0&IoT), Vol-4, No-1,2018

[6] AFREEN IQBAL et al, Adoption Of IOT in Automobiles for Driver's Safety Key Considerations And Major Challenges, International Journal Of Scientific & Technology Research, Volume 8, Issue 09, 2019.

[7] https://www.obdautodoctor.com/scantool-garage/diagnostic-trouble-codes explained.

[8] Shijiao Guo,Hongxia Xia,Guangli Xiang, Research on the translation from XSD to JSON schema, IEEE 9th International Conference on Communication Software and Networks (ICCSN), 2017

[9] Vidushi Jain,Aviral Upadhyay, MongoDB and NoSQL Databases, International Journal of Computer Applications (0975 – 8887), Volume 167 – No.10, June 2017

[10] Reza Malekian, Member, IEEE, Ntefeng Ruth Moloisane, Lakshmi Nair, Member, IEEE,B. T. Maharaj, Member, IEEE, and Uche A. K. Chude-Okonkwo, Member, IEEE, Design and Implementation of a Wireless OBD II Fleet Management System, IEEE SENSORS JOURNAL, VOL. 17, NO. 4, FEBRUARY 15, 2017.