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Cyber Physical System for Traffic Behaviour Analysis

Syed Hadier Ali[1*], Syed Waqar Shah[2], Syed Ashraf Ali[3],

[1]*Research Scholar, Department of Electrical Engineering, University of Engineering and Technology Peshawar*
[2]*Professor and Head of Department, Department of Electrical Engineering, University of Engineering and Technology Peshawar*
[3]*Lecturer, Iqra National University Hayatabad Peshawar*

Abstract — *In this research, an OBD-II (On Board Diagnostics) based System is to transmit information Proposed to a remote server. The transmission subsystem obtains the data from ECU (Electronic Control Unit) through the use of the ELM-327 OBD reader, and it is processed using a microcontroller (Arduino Uno). Then, it sends the information to a remote server on the cellular network using the GSM SIM900A Module. The reception subsystem is set in a remote server and includes: a service to read the received data, a database to check the stored information. The system also implements GPS tracking to determine the location of the vehicle and the road conditions. The major benefits of the projected device embrace complete access the data that available through OBD-II (On Board Diagnostics), and adaptability for on-device data processing and/or cellular transmission. Overall, through this platform various future research opportunities arise including identify bottlenecks, Driver behaviour, inefficiencies in road network their related costs, Green house emission and many other things.*

Keywords*-on board diagnostics, internet of things, GPS, intelligent transportation, GSM, Thingspeaks*

I. INTRODUCTION

Now a day, the automotive industry promotes new technologies and practical solutions in order to improve performance, comfort and safety in cars. Among the most important innovations is the inclusion of the OBD-II systems, initially aimed at monitoring the components of the car, and now allows to verify the operation and performance of the car is optimal. Although there are works that are based on OBD-II, should be aware that they use a wireless short-range communication, becoming a big disadvantage for the user because the only way to monitor transducers engine car it is being inside the same. In order to have the ease of which we can access the dataset from anywhere, it becomes necessary to store information on a remote server, and accessible from Internet. Once the data is stored, they could be prosecuted and provide various future services.

This project proposes the design and implementation of a solution that uses the microcontroller to read ELM327 OBD-II codes to collect a data set from the Control Unit Engine (ECU, Engine Control Unit); collecting and sending data to the remote server is done via the Arduino Mega 2560 with its respective device GSM module; storing data Management Database System (Thingspeak). The paper consists of five sections, the first part presents the main characteristics, the description of components, measurement modes, and the communication protocols of the OBD-II system; The second part presents related studies, the third part details the system architecture design and implementation of the proposed solution; the fourth part details the performance testing and results of the proposed solution, and the last presents the conclusions.

II. RELATED WORK

K Smith et al. [1] introduced a framework that stores a large number of vehicle data from various sensors, such as GPS and OBD-II on web. This process is implemented on top of the microcontroller because of its accessibility and network support. Briefly, the microcontroller is connected GPS module, OBD-II-UART Board and GSM / GPRS module. The microcontroller has the ability to access and translate any existing OBDII CAN Bus protocol data. Furthermore, the module can perform easy on-board processing and send exhaustive calculation to the server using the GSM module.

A. Athavan et al. [2] introduced a framework of data collection for automobiles with low memory requirements and real-time data analysis. Their system consists of OBD-II with CAN Interface, OBDII to CAN Converter, OBDII CAN Converter and cloud server. The module pre-processes the samples collected by the microcontroller and stores them to the cloud server. This pre-processing expressively reduces the amount of data stored and transmitted to the cloud server, making the operation simpler. Initial, the controller retrieves automobile data from on board diagnostic. The data is then stored on the controller while the automobile is traveling. At the end of the trip, data is transmitted from the controller to the cloud server using the GSM module. Finally, when the information is accessed to the server, data analysis is performed and knowledge is created.

C. E. Lin et al. [3], [4] Collected warning information from automobiles using on board diagnostic. After data is collected, the data is transmitted to the maintenance platform for real-time processing using 3G.

E. Ceuca et al. [5] Introduces an electric vehicle tracking systems using OBD drivers and GPS/GSM. The scheme uses GPS / GSM to monitor automobile location and send location coordinates to a storage server periodically. The scheme also linked the automobile to the driver's smartphone using Auto Link that could detect any accident and used the phone to report the accident to 911, providing the necessary information such as vehicle description, driver name and location. The OBD was used to read the speed of the automobile and other information and to associate this information to energy recovery to reduce power consumption, as described in [6]. The OBD was also used to read user-friendly information on automobile status through a mobile app.

Z. Ji-Hui and others. [7] Proposed a platform for obtaining information from electric automobiles and transferring them to a server by means of GPRS module. The data in the automobile is collected and sent to a server for analysis. The information collected helps to predict important information such as fault, driving cycle, control strategy, reliability and driving patterns.

III. SYSTEM ARCHITECTURE

A. Arduino

Arduino is an open source platform to do prototyping using hardware and software that is easy to use. Arduino can read the various inputs such as position switches, light, finger scan, Bluetooth, Wi-Fi, Twitter messages, and control the output based input on it, such as motors, LED, LCD, even doing an online publication.

B. Engine Control Unit

Engine Control Unit (ECU) is an electronic control unit that controlling the actuator series, from internal combustion engine to obtain optimum engine performance. ECU works with the car reading the various sensors on the engine.

C. On board Diagnostic System (OBD)

OBD system has a microcontroller-based system and monitor sensors mounted on the vehicle to observe the various parameters related and emission control systems / Device, the processing unit will take input from the sensor to be processed by the signal conditioner and will be calculated the value of real-time vehicle then provide output parameters. The system will be able to diagnose faults in the parameters, such as sudden changes abnormal, notifying the user of a normal condition, and shows the cause of the error. OBD system installed in vehicle for increase in fuel efficiency and controlling emissions from the flue gas, in addition to the OBD system also provides warning to the driver of the damage caused to the vehicle.

D. ELM 327 Interface

ELM327 is a device based microcontroller Special PIC programmable designed to handle communication in OBD-II standard. It operates on a 5V power and provide feedback debugging through 4 LEDs indicate data exchange. Data received through one of the three standard signals and then by the ELM327 which interprets the data and sends the standard RS232 line which can be read by ATMega644. Similarly, when a command is sent to the ELM327 by the MCU, it is interpreted and converted to the correct signalling protocol which is then transmitted to the car. ELM327 does not read commands or data moderate posted but only convert ASCII data on a RS232 line to the proper voltage in OBD-II port.

E. Bluetooth

Bluetooth is a wireless technology standard for exchanging data on the distance. The frequency band for Bluetooth communication is 2.4 to 2.485 GHz. In this research work Bluetooth HC-05 module is used. HC-05 Bluetooth serial module operates on 3.3V and current flows around 30mA while other devices are Generally operating on a 5V to 12V. Use of Bluetooth in this research to receive and transmit data between the Arduino and Bluetooth OBD. Bluetooth is also easy to use with microcontrollers to create wireless applications. Interface used is the serial RXD, TXD, VCC and GND. Built-in LED as an indicator Bluetooth. Effective distance range of 10 meters. Bluetooth is connecting with Arduino shield as a means of communication between OBD II through ELM327.

F. Hardware Design

This research is based on both hardware and software designed, so that a compact system can retrieve and display data directly in front of the driver's and also data transmit to cloud server. Design based on microcontroller Arduino as centre data controller of the OBD-II via Bluetooth, as shown in Figure 1.

Data from the engine control unit will be read by Arduino through ELM327 OBD-II adapter. ELM327 OBD-II it is used as an adjustment to the data communication between the ECU with serial RS232. The data received by Arduino must be translated by the device software is embedded in the hardware. The vehicular data such as the engine RPM, engine coolant temperature and MAF sensor is transmitted to the cloud platform (Thingspeak).

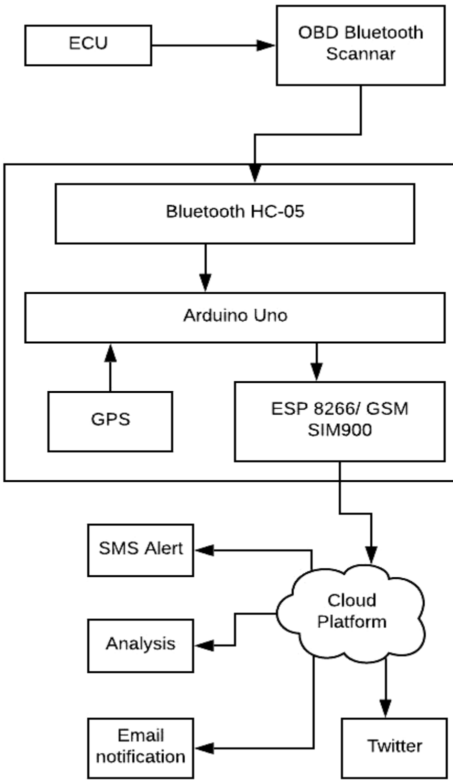

Figure 1. Block Diagram System

G. Design Software

The program is designed in accordance with the flow chart in Figure 2. Below.

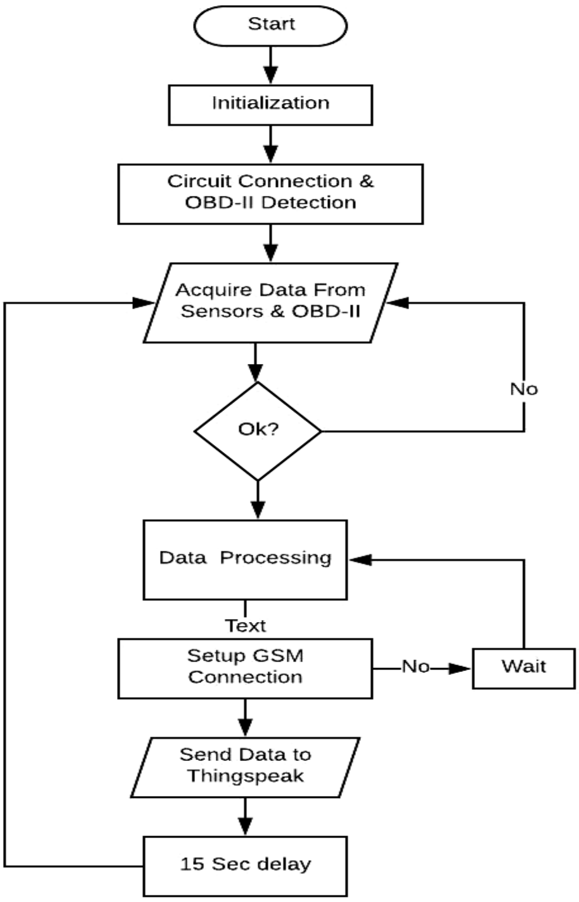

Figure 2. Flowchart Program

IV. TESTING AND IMPLEMENTATION

Testing was done on X Corolla 2005 model manufactured by Toyota Motor Company. Functionality was tested four PID codes from engine control units (ECU). For detecting coolant temperature, engine revolution per minutes and mass air flow enough to have turned the ignition key, the engine speed test vehicle had to be started up, and if measuring vehicle speed was necessary to have driven some distance. In Figure 3. Log measurements sent from the transmission subsystem and are stored in the database is shown.

Figure 3. Measures stored data in cloud platform.

A. Testing Coolant temperature

To test temperature delivered code "0105" to the OBD then the subroutine used is

	Mode	PID
Request	01	05

If the OBD receives a request with the code "0105" will be sent back by the response

	Mode	PID	Byte A	Byte A	Byte A	Byte A	Byte A
Response	01	05	XX	00	00	00	00

The data received cannot be understood then must be translated into decimal numbers with the formula:

$$\text{Coolant Temperature } (^\circ C) = XX - 40$$

From formula The temperature data displayed with hexadecimal base number decreased by 40 to get a decimal value, Figure 4 requests and acceptance testing temperature data.

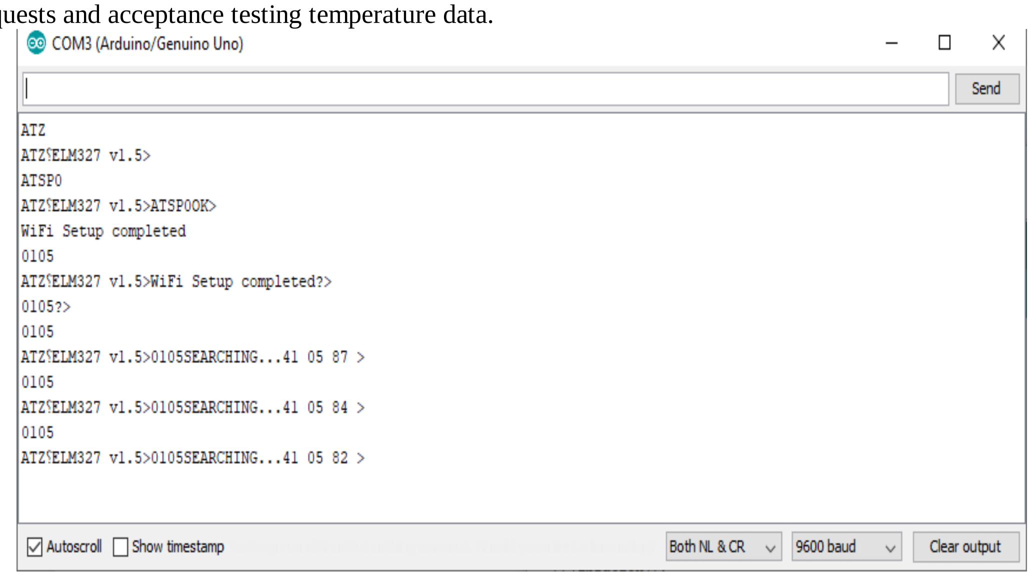

Figure 4. Testing and receipt of vehicle coolant temperature data.

Figure 5 Photo tools during operation value Coolant temp 95 °C

B. Testing of engine RPM

Engine RPM rotation per minute ratio is a parameter for reading rev the engine in a unit time. Data from OBD to rev the engine can be requested by sending a code string "01 0C". If connected, the OBD system will immediately sends a response back with string"0C 41 00 00 00 XX YY". From the responses received are "41 0C 0F 23", then the value of the known RPM is equal to 968.75.

This value can of formula RPM = ,25 * (XX * 256 + YY).

Figure 6 is a test request and receiving data engine RPM.

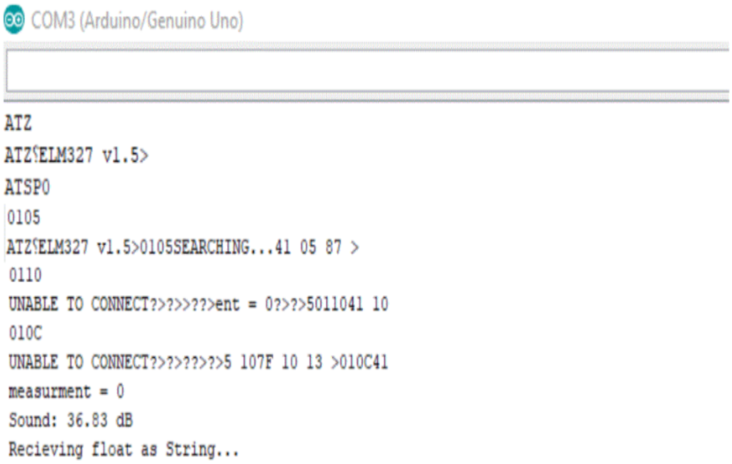

Figure 6. Testing and receipt of vehicle RPM data.

Photo tools during operation value of RPM 1027

C. Speed of Vehicle

To request data on OBD string "010D ". If the string OBD receive the OBD will respond by sending a string with the format "XX 0E 41 00 00 00 00". Data sent by OBD, just converting this hexadecimal value to decimal value would yield the value of speed.

Photo tools during operation value of Vehicle speed 15 km/h

V. CONCLUSIONS

The aim of this paper was to study the standard OBD-II, which is used for reading diagnostic data from the vehicle controller and based on this standard to suggest the possible extension of the existing process solutions, which currently accounts for retrieving data from the OBD-II module into microcontroller (Arduino Uno) via Bluetooth. The most effective method of modification has been selected to send vehicular data to the cloud platform (thingspeak). This system can be used for various future research opportunities such as, traffic monitoring, identify bottlenecks, Green house emission, Driver behaviour and many other things.

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