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Design and Development of OBD-II Compliant Driver Information System

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Abstract

Background/Objectives: On-Board Diagnostics, or OBD, in a vehicle connection, is a term alluding to a vehicle's logical toward oneself and reporting ability. OBD systems give the vehicle proprietor or a repair expert access to condition of origin data for different vehicle sub-systems. **Methods/Statistical Analysis:** The driver data framework (DIS) is connected in a vehicle through OBD-II connector. Initially, live information undertaking that gives real time gauges reading. The live information is constrained to show an ambient temperature, Throttle position, Intake manifold absolute pressure, MAF air flow rate, calculated engine load value, intake air temperature, Engine coolant temperature, RPM and vehicle speed (km/h). Second assignment is DTC filtering framework that offers diagnostic trouble codes. **Findings:** The point of this venture is to get a completely useful Programmable System on Chip (PSoC) platform working with observing live data monitoring and DTCs corresponds with all present day vehicles. Correspondence to and from the ECU will be done utilizing the On-Board Diagnostics two (OBD-II) standard. The correspondence with the ECU must be taken care of utilizing a surveying sort system as information programmed overhauling of information from the ECU isn't possible sporadically. Rather a cyclic process or string will need to run ceaselessly to do a question to the ECU took after by the perusing of the answer. The product will need to work with the returned hexadecimal information in a manner that gives the client or driver valuable information. **Conclusion/Improvements:** Driver Information System (DIS) helps effective and efficient use of vehicles and can assist a relatively inexperienced drive to shift to proper gears or proper acceleration according to the load on the engine and there by achieve better fuel economy and better emission performance.

Keywords: Automotive Applications, Driver Information System, ECO Driving, OBD-II Standard, Scan Tool

1. Introduction

All vehicles are fitted with an instrumentation cluster that is utilized as a driver data focus, earlier known as a dashboard. It contains different gages and pointers that give important parameters to the driver[1]. Gages give scaled sign of the system situation, for example, vehicle speed, engine speed, fuel level and distance etc. While, the indicator lights supply data of something is being turned on or caution the driver about system breaking down issues. Present day vehicles are controlled electronically utilizing continuous programming in a gadget known as the Engine Control Unit (ECU)[2]. This permits the vehicle to adjust to environmental conditions, for example, air thickness, it will proportion the fuel injected accordingly enhancing mileage. The ECU controls numerous other sub systems of the engine, for example, the Anti-locking Braking System (ABS). All choices made by the ECU are in view of the condition of sensors that are set at different places all through the vehicle basically around the motor cove.

As years went on, the ECU got to be more equipped for supplying indicative and sensor information to help mechanics distinguish the source of issues that emerge in the engine control unit. In the long run a standard was made that all makers were urged to take after. The standard got to be normally known as On-Board Diagnostics (OBD)[3]. The presentation of the standard

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was in a push to encourage vehicle makers to outline more dependable outflow control systems. OBD-II is an upgrade of the OBD standard that was presented later and made required[4].

With the achievement of the OBD-II, European nations oblige all petrol cars since 2001 and diesel cars manufactured from 2003 onwards, to prepare with European On-Board Diagnostic systems (EOBD) that proportionate to OBD-II standard. The OBD-II had been standardized by the Society of Automotive Engineers (SAE) and upheld by the International Standardization Association (ISO). This standardization incorporates regular terms and acronyms, a typical diagnostic connection connector and area, regular diagnostic test modes (nonexclusive and improved), a typical scan tools, a common diagnostic trouble codes, a basic scan tool and a typical communication protocol standard[7]. OBD-II information can be gathered through one of five communication protocols that are recorded in Table 1. The format of the command needs to take after the SAE J1979 standard (normal diagnostic test mode). The OBD-II models were basically created to manage vehicles emission level guidelines.

Table 1. Communication protocols

NO.	Protocol	Speed
1	SAE J1850(VPW)	10.4 kbps
2	SAE J1850(PWM)	41.6 kbps
3	ISO 9141-2	10.4 kbps
4	ISO 15765-4(CAN)	500 kbps
5	ISO 14230-4(KWP 2000)	10.4 kbps

2. Background Theory

Early examples of OBD would basically light up a malfunction indicator light, or MIL, if an issue was identified yet would not give any data as to the way of the issue. Current OBD usage utilize a digital communication port to give real time information notwithstanding a standardized arrangement of Diagnostic Trouble Codes, (DTCs), which permit one to quickly distinguish malfunctions within the car.

2.1 History of On-Board Diagnostics (OBD)

In 1970, the US government congress passed the Clean Air Act[9]. Vehicles were an enormous supporter to contamination noticeable all around. This required another standard to be presented, the OBD standard. The standard itself was created by the Society of Automotive Engineers (SAE) amid the late 1980's. At the time some producers had their own exclusive observing and reporting systems and specific devices were needed so as to peruse this data. OBD was the first and foremost standard of its kind its fundamental design was to urge producers to make more effective engines, in this way prompting decreased emissions and better efficiency. The first OBD standard was not flawless; it had a ton of issues, fundamentally the accompanying:

- The Data Link Connector (DLC) in which scan tools would interface with the ECU was not standardized. This avoided non-specific scan tools being made that would work with all vehicles.
- Each vehicle maker had their own remarkable arrangement of diagnostic codes for distinguishing issues in the engine control system. This was another real issue for making nonexclusive diagnostic equipment.

These issues prompted the improvement of a fresher standard that would battle these issues and give better standardization. OBD-II was produced in 1996. It bolstered better standardization to the regions in which the first form of OBD failed. A standard data link connector was made obligatory by the determination. The connector[6] is characterized by the J1962 standard that the SAE determined. This new standard DLC permitted diagnostic equipment producers to create nonexclusive equipment that dealt with any vehicle. Diagnostic Trouble Codes (DTCs) were made standard however producers were still permitted to incorporate more itemized exclusive ones. Four classes of codes were presented for distinctive territories of the vehicle. These code sorts are talked about further in the impending areas.

The heart of this paper is tied in nearly with the On-Board Diagnostics (OBD) standard and all the more particularly the OBD-II form which is the most advanced form. OBD is an innovation that is implanted inside an Engine Control Unit (ECU).

Eco driving is a new area on which a considerable measure of prominence is given at present. As expressed by Sterwart A[1] effective driving assumes a critical part in sparing of fuel. There are numerous works which demonstrate this announcement, for example, in Vasso Reppa[2]. Eco driving is essentially a general guidance to the driver to change the driving conduct. The advices can be somewhat like, accelerating gradually, diminishing top speeds thus on concurring to George Dimitrakopoulos[3].

The paper expresses that by utilizing on going advices the driver's conduct can be dealt with such that he drives in a temperate way. Fuel consumption versus average cruise speed generalized functional relationship is shown in Figure 1.

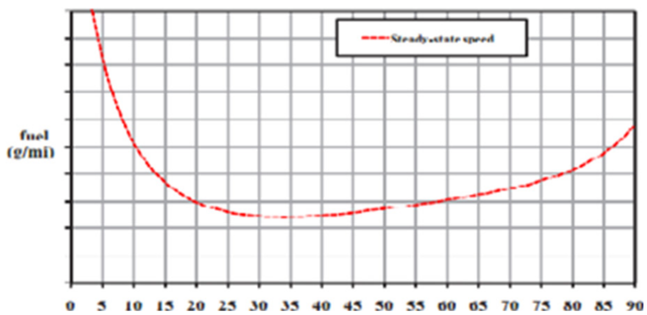

Figure 1. Fuel consumption versus average cruise speed generalized functional relationship.

George Dimitrakopoulos[3] additionally recommended that at lower and at higher speeds there is more consumption of fuel. As should be obvious from the figure above, at lower speeds the fuel consumption is the greatest and as we continue enhancing the pace, after a specific point the consumption again begins increasing. This is because of the Wind resistance

Lucas Malta recommended that[7] in this paper "On-Road Motor Vehicle Emissions and Fuel Utilization in Urban Driving Conditions" has expounded on the fuel utilization in urban driving conditions as well. In this paper the information are taken from four separate models of vehicles with diverse weights and acquired the information of the drives in urban conditions. It is said that an equation to figure the normal fuel utilization calculate as demonstrated as follows. Formula for Average Fuel Consumption Factor is below:

$$\text{Average Fuel Consumption Factor [g/kg]} = \frac{3600 \times \sum f\left[\frac{g}{sec}\right]}{\sum v\left[\frac{km}{hr}\right]}$$

Where f is the instantaneous fuel consumption rate and v is the instantaneous speed. They state that the fuel consumption factor is inversely proportional to speed. This could be quite useful in the calculation of fuel consumption.

There have been various eco driving projects in Europe and the outcomes have demonstrated that there has been a mileage change of 5% to 15%, as indicated by Lucas Malta[4].

Saif Al-Sultan[5] has done an examination on utilizing constant announcement on mileage. They presented a prompt constant announcement system which gives the driver insights about the current outing economy, CO_2 and fuel emissions and so forth. This was all done to analyse how a continuous announcement system would influence the driver's conduct and the fuel economy. For this, they utilized an effectively existing eco driving gadget called Eco-way and OBD-II standard. They joined the OBD-II gadget to the Eco-way gadget utilizing an OBD link. The results demonstrated that on an average, there was a change in mileage of 6% on city streets and of 1% on interstate streets.

3. Implementation

3.1 DIS Requirements

The Driver Information System (DIS) is connected in a vehicle through OBD-II connector. Ordinarily, this connector is situated underneath the steering. There are nine parameters that would be shown on the LCD. The DIS shows ambient temperature, Throttle position, Intake manifold absolute pressure, MAF air flow rate, calculated engine load value, Intake air temperature, Engine coolant temperature, RPM and vehicle speed (km/h).Second requirement is DTC filtering subsystem that offers DTC checking status and diagnostic trouble codes. It also helps to assist driver. It also display gear shift and eco mode on the LCD display.

3.2 DIS Features

The hardware setup for OBD-II Compliant Driver Information system is shown in Figure 3. The OBD-II interface unit utilizes a mediator chip that would naturally create the interface between the ECU and microcontroller. The system supports only ISO 9141–2 protocol. Through this interface unit, the OBD-II information can be gathered utilizing a RS232 communication protocol in the microcontroller.

3.3 PSoC Platform

Programmable System on Chip processor (PSoC) is utilized as an embedded processor of this project[11]. The PSoC board comprises of a pluggable character LCD module with contrast control, status LEDs, a UART, an RS-232 interface, and ISSP programming header and prototyping area. Power supply needed for the board is provided by Miniprog. Miniprog gives the capacity to program PSoC parts rapidly and effectively. PSoC microcontroller is based on 8 bit CISC architecture[11]. The board features of analogy and digital programmable blocks, which themselves permit the usage of large no. of peripherals. The PSoC programmer kit is shown in Figure 2. Block diagram of the DIS is shown in Figure 3. Flow chart of DIS is shown in Figure 4. DIS hardware setup is shown in Figure 5.

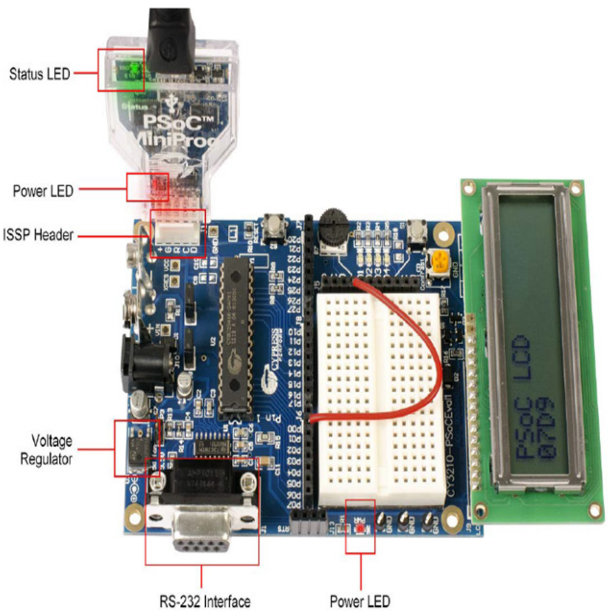

Figure 2. PSoC Programmer Kit.

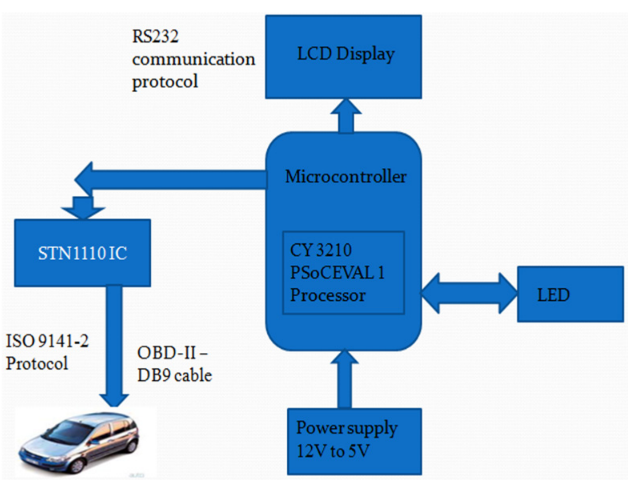

Figure 3. Block diagram of the DIS.

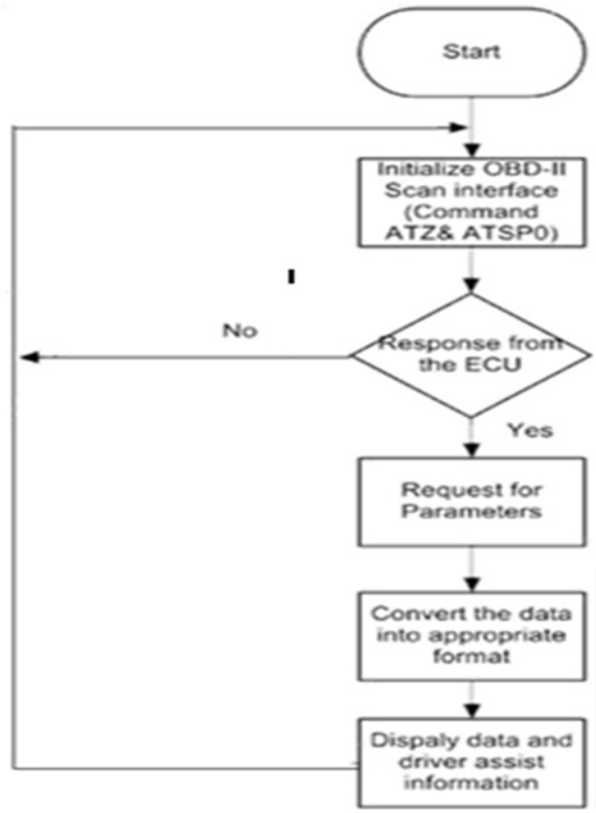

Figure 4. Flowchart of DIS.

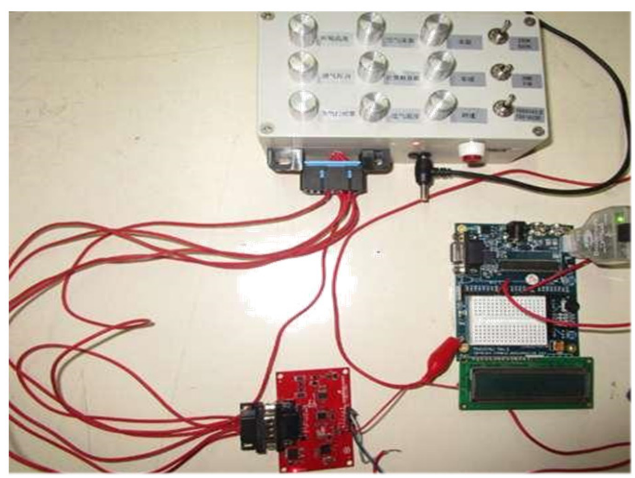

Figure 5. Hardware setup for OBD-II Compliant DIS.

3.3.1 PSoC Features

- AC unit, hardware 8x8 multiplication, with result stored in 32-bit accumulator.
- Programmable frequency choice.
- Changeable working voltage, 3.3V or 5V.

- Possibility of small voltage supply, to 1V.
- 16K bytes of programmable memory.
- 256 bytes of RAM.
- AD converters with maximum resolution of 14 bits.
- DA converters with maximum resolution of 9 bits.

4. Results

To send an OBD-II order to the ECU, you basically send the ASCII equal to the mode number connected with the Parameter ID (PID). For example, so as to view the current engine coolant temperature, a mode 01 and PID 0C is needed. To send this to the ECU of the vehicle, send the mode and parameter ID of coolant temperature “0105” to the STN1110. The STN1110 will then insert this information in the payload field of an OBD-II message and send it on the ECU. At the point when the ECU is responds with sequence of bytes in ASCII format that need to be converted into the decimal and again converted into ASCII and displayed it on the LCD of the PSoC. RS-232 protocol is used for the communication. The DIS is used to monitor live data information and DTCs.

Figure 6. Reset of the board.

Vehicle information can be acknowledged through the OBD-II interface. The message from ECU of the vehicle organize “010D”, “01” demonstrates Mode 01 and “0D” shows the PID, which asks for Engine speed. The vehicle’s ECU reacts with “41 0C 0F”. In the message “41” demonstrates that is reacts to Mode01, “0D” demonstrates the asked for PID and “0F” is a genuine vehicle’ speed. Reset of the board is shown in Figure 6. The speed value is in hexadecimal organization and that need to be changed over into decimal on the other hand changed over to ASCII and converted value is shown on the LCD. Speed value is displayed on the LCD is shown in Figure 7. RPM value is displayed on the LCD is shown in Figure 8.

Figure 7. Vehicle’s speed value is displayed on the LCD.

Figure 8. Engine RPM value is displayed on the LCD.

When the RPM of the vehicle is greater than 4500, the gear “SHIFT DOWN” is displayed on the LCD is shown in Figure 9. The diagnostic trouble codes are illustrated in Figure10. P0143 denotes O_2 sensor circuit low voltage.

Figure 9. Shift Down is displayed on the LCD.

Figure 10. DTC is displayed on the LCD.

4.1 Testing OBD-II Compliant

The test setup is comparative with the test setup from our past work. The just distinction is the expansion of the ELM327 Bluetooth scan tool. Once the ELM327 Bluetooth is connected to the ECU simulator, the Bluetooth on the android device is turned on. After the Bluetooth is turned on, the application "OBD auto Doctor free" can be opened .The android gadget and the ELM327 scan tool to be paired, just open the android device, in the settings menu, click "connect", then the parameters are shown on the android gadget screen. While selecting each parameter then the corresponding values are displayed on the android device screen. In order to check correctness of the parameter value displayed on the LCD of the microcontroller, it is compared with ELM327 Bluetooth Scan tool. Engine RPM value is displayed on the LCD is shown in Figure 11.

Figure 11. Engine RPM value is displayed on the LCD.

5. Conclusion

The configuration and advancement of a driver information system taking into account OBD-II convention utilizing embedded processor architecture was presented. It is an embellishment apparatus that give the data identified with the driver. The proposed DIS backings administrations, for example, checking of Vehicle Speed, Engine RPM, Ambient temperature, Throttle position, Manifold absolute pressure, MAF air flow rate, Intake air temperature, Engine coolant temperature and DTCs. If a user is interested to broaden the code for all the accessible PIDs simply needs to include the particular code in data format of the solicitation PID technique. The system executed in this venture underpins all the fundamental prerequisites of the OBD-II test tools. The non-specific output device grew in this undertaking can be utilized on any modern vehicle.

As the generic scan tool grew in this venture is a Cy3210-PSocEVAL1 based scan tool, it is moderately simple to recovered information from the vehicle and to showed information to the LCD on the microcontroller. This helps the administration method to effortlessly distinguish the issue happens in the vehicle.

This helps the administration method to effortlessly distinguish the issue happens in the vehicle. When the RPM of the vehicle is greater than 4500, the gear "shift up" is displayed on the LCD. Whenever RPM is less than 2500, the gear shift down is displayed on the LCD. By displaying this information on the LCD the fuel efficiency can be optimized by reducing fuel consumption. When the speed of the vehicle ranges between 50 and 70, then ECO will be displayed on the LCD. ECO mode adjusts engine operation so you get more continuous speeding up and change to higher gears sooner. Fuel efficiency and eco driving is successfully accomplished. Eco driving is proportional to amount of energy consumed by the vehicle. The future work might be to design a product where once the user presses the switch, the speed will be displayed on the LCD. Trip information report, accident log and maintenance reminder data, these feature can also be added as additional features. Make the application available to all car models. Put in actual calculations so as to show, how much fuel is saved. Implement maps and enable the user to know when there's a signal or a crossing coming, using voice alerts and make the drive much more fuel economic. Extend the application to include features that let the user know a change in air pressures of the tires, driving conditions etc. on the device itself.

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