An OBD Based Heads up Display for Automobiles

Anujaraj V[1], C B Bromy[2], Johns Vinod[3], Nithin Prakash[4], Binsa Mathew[5]

B.Tech. Student, Dept. of E.C.E., HKCET, Mahatma Gandhi University, Kerala, India[1,2,3,4]

Assistant Professor, Dept. of E.C.E., HKCET, Mahatma Gandhi University, Kerala, India[5]

ABSTRACT: Conventional consoles are positioned in such a way that they grab driver's attention off the road while driving. Also automotive, navigation, entertainment requirements have congested the dashboard area that might distract the driver. Augmented reality has attracted attention in many fields nowadays and Heads Up Display in automotive industry has potential to alter the overall user experience of the driver. The Controller Area Network (CAN) inside the vehicle keeps on monitoring the sensors that is present in the vehicle. This sensor values is provided through the OBD (On Board Diagnostics) port which is widely used for vehicle diagnostics. Vehicle speed, rpm and engine temperature sensor values are extracted from the OBD port and using sufficient conversion values are obtained. Values obtained are presented to the driver in a visually appealing way by the means of a projector. Small portion of the windshield is used for projection in order to ensure visibility of the road.

KEYWORDS: Heads Up Display, On Board Diagnostics, Parameter ID, ELM327.

I. INTRODUCTION

Safety is a major cause for innovations in automobile industries. Advances in automobile electronics, navigation system, and entertainment systems have generated a need for new interfaces and methods for representing vital information to driver. But limited availability of cabin space infotainment systems have burdened dashboard area thus distracting the driver.

New technologies are developed in order to endure safer driving. Some of these are state of art systems like intelligent night vision, collision warning. Fixed displays might take drivers attention of the road. Heads Up Display are becoming more prevalent in high end automotive at least as an luxurious accommodation. These displays present required information into the field of the driver thereby increases safety and comfort since driver doesn't need to take his attention away from traffic ahead. Windshield utilization is a solution for projecting information into driver's field of vision.

This project was a novel idea of presenting a virtual console to the driver such that driver need not take attention off the road. Electronic Control Unit (ECU) of the car keeps on monitoring several sensors and from that required Parameter ID's is extracted through the OBD port present in the automobile. Using the parameter ID's (PID) sensor data is extracted and it is converted into understandable set of values. Speed, rpm and engine temperature are extracted from the ECU using corresponding PID's. Since sensor data keeps on changing with time dates are stored into a separate file and File content gets updated periodically. Using the generated file as a pointer a Graphical User Interface (GUI) is generated. Raspberry Pi is used for the purpose of generating this GUI and this is drawn out through the HDMI port of the same. A Pico projector is used to project the GUI onto the windshield of the car. Small part of the windshield is used for this purpose such that remaining part provides ambient visibility for the driver. In order to increase the overall visibility a thin transparent film can be applied on to the windshield.

II. RELATED WORK

The majority of the research based on HUD in the automobiles are interfaces the driver assistance system. Anup Doshi et al.[3] introduces a system which is capable of actively interfacing with the human as a part of driver assistance system with the help of HUD and the Dynamic Active Display (DAD). But Min Woo Park et al.[6] proposes a windshield head up display based on homograph based calibration to visualize the road scene and information of

detected vehicles. The detection of vehicles based on the shapes of designed square bracket. The disadvantage of this system is that it will not give effective visualization. Nowadays researchers give contributions in the automobiles by integrating information systems and smart phones with the vehicles to improve the driving experience. Oscar Alvear et al.[2] introduces a system which integrates mobile apps and the vehicles. This can be achieved on all existing vehicles by connecting on the On Board Diagnostic (OBD II) interface. The advantage of this approach include allowing to generate vehicle parameters patterns and GPS functionality. S.M Mahajan et al.[4] develop a Head Up Display Technique that display the required information in the windshield in a manner that allows the driver to view it while looking in the forward scene. Prasant R et al. [1] develops an HUD for connected car for maintenance and emergency intimation. This study deals with the development of both vehicle and driver to prevent problems. CAN (Controlled Area Network) used for the communication. If any abnormalities occurs while driving, a message will send to the corresponding authorities. This can give an advancement in the automobile industry.

III. PROPOSED METHODOLOGY

Even though the data extraction through OBD port was present for many years, it was mainly used for the purpose of automobile troubleshooting. Current HUD systems use assistance of additional sensors or devices for finding data like speed. This increases the overall cost as well as reduce the accuracy. For accurate as well as economical HUD system, we are introducing this project. Instead of using additional equipment's required data i.e. speed, rpm and engine temperature is obtained using the preinstalled sensors which are proven to be reliable and accurate at all conditions. The sensors embedded are designed in such a way that they keep on sensing values at all time. Thus, by obtaining values of this sensor it is possible to create a proper knowledge about the values.

An ELM 327 OBD scanner is used to take values from the car's OBD port. ELM 327 is a programmed microcontroller produced by ELM electronics and it is used for translating On Board Diagnostics interface found in automobiles. The ELM 327 scanner extracts the required values by using corresponding Parameter ID's.

A Raspberry Pi 2 model B is used as the central unit of the system as it is very much versatile and creating a GUI is much of an easier task. Data extracted by the OBD scanner have to be transferred to the Raspberry Pi and hence an ELM327 with inbuilt Bluetooth is used. The ELM 327 Bluetooth scanner is connected to the Raspberry Pi with the help of a Bluetooth adapter. A python code is written inside the Raspberry Pi to extract values of the sensors. From this another python code is used to convert sensor values into understandable form and then it is saved into a file.

A GUI is designed with the help of a JavaScript that runs in a browser window. This JavaScript takes value from file and using the value gauges are plot in the GUI. Raspberry Pi sports an HDMI output port through which the GUI display can be passed on to the projector. A short throw Pico projector is used to project this GUI into the windshield. The Raspberry Pi is coded in such way that from start-up it works headless. A python code is written which will automatically pair the Raspberry Pi with ELM 327 Bluetooth Scanner at start up.

III.I BLOCK DIAGRAM
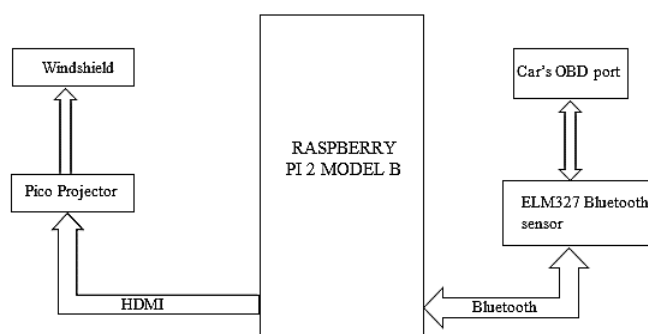
Basic block diagram of the project is as shown below:

Figure 1. Block Diagram

Input is obtained from the automotive OBD port of the vehicle. OBD port or SAE J1962 diagnostic connector is usually located under the dashboard. It has spaces available for sixteen Pins. Pin locations vary depending on the signal protocol supported by the vehicle. Even though there are many OBD scanners available ELM 327 is used because supports almost all of the protocols.

The OBD scanner is powered by the automobiles electrical harness thus it doesn't need separate battery or external connections. Once the device is hooked up when car is turned on device gets activated. It has low power sleep mode which draws very less power when it is not being used. Data from this device is obtained by first setting up a connection with it and then sending request for data. If device is connected it will respond to request by sending packet over the Bluetooth containing data being requested. Next step is to setup the main processing unit to communicate with the scanner.

Raspberry Pi 2 model B is used as the heart of the system. Raspberry Pi 2 model B is used because comparing to its predecessors it have better performance with the aid of increased speed and RAM. For setting up the Raspberry Pi first we connect a USB Bluetooth adapter to the Pi to allow it to pair with Bluetooth devices. Once the Bluetooth is setup, Raspberry Pi paired with the OBD II sensor.

To setup the communication with ELM327 scanner a python program is written which abstracts OBDII communication protocol. Using the python code an OBD sensor object is created which contains and setup all communication with the Raspberry Pi. After creating an object connection initiation request is send on receiving which the sensor responds with an acknowledgement signal and tells the program all kind of data that it supports. After verifying the connection requests for data's needed for HUD are sent. Sensor responds with a large packet of data which contains required sensor data. Sensor initially gives a large HEX number with several header bytes and it is processed by the Pi to generate a human readable numbers with proper units.

Once data is processed it is stored into a file for further use. Separate files are used for storing values of speed, rpm and engine temperature. The files remain same but contents of the file is updated at regular intervals. The GUI for the HUD is designed using a JavaScript. The JavaScript polls this data stored in the file at a constant rate.

Separate JavaScript files are created for each of the sensor data's. After creating separate JavaScript's they are combined together to form a single window that shows 3 JavaScript section together. This browser window is projected out through the HDMI port of Raspberry Pi. HDMI output is connected to a Pico projector that have good level of brightness level and contrast that the projected display is visible even under sunlight. GUI is projected onto the windshield of the car. The processes starting from pairing with the OBD II scanner to projecting the GUI is made autonomous so that at vehicle start-up Pi automatically connects with the ELM327 scanner and starts to project the GUI onto the windshield.

IV. HARDWARE IMPLEMENTATION

Raspberry Pi 2 model B is used as the heart of the system. Raspberry Pi is a single board low cost computer that can be used for learning programming and projects. Raspberry Pi has different iterations and Raspberry Pi 2model B has better performance compared to its predecessors. Raspberry Pi 2 model B sports a 900 MHz processor with 1GB of RAM. What makes it more desirable is the presence of 4 USB ports, HDMI port, 40 GPIO Pins, Ethernet connectivity, audio output and much more. The Raspberry Pi normally runs at an input rating of 5v 1A.

A mini USB Bluetooth adapter is connected into one of the USB ports of the Raspberry Pi. OBD port is present in almost every vehicle produced since 1980's. An ELM327 scanner is connected into the OBD port of the vehicle. The ELM327 scanner has a low power consumption of around .75 watts under normal operation and as an added benefit a low power sleep mode enabling it to remain passive when connected but not used. The ELM327 scanner is paired to the Raspberry Pi using the Bluetooth adapter.

A Pico projector is a small projector that could be easily hold by single hand but packs sufficient instruments to keep the name high. It can be considered as a response to the emergence of compact portable devices which have sufficient specs but little space to attach an added larger display. Pico projector involve miniaturized hardware and software that can project digital images onto any viewing surface. The Raspberry Pi and Pico projector is powered by the auxiliary power commonly called as car charger port.

V. SOFTWARE

V.I LANGUAGE USED

Language used for programing Raspberry Pi was python. Python is a high level general purpose programming language. Python offers an easy syntax which allows programmers to express concepts in fewer lines of code compared to C++ or java. Raspberry Pi supports python out of the box.

JavaScript is used to create the required GUI. When compared to languages like c JavaScript trades performance for better expressive power and dynamism.
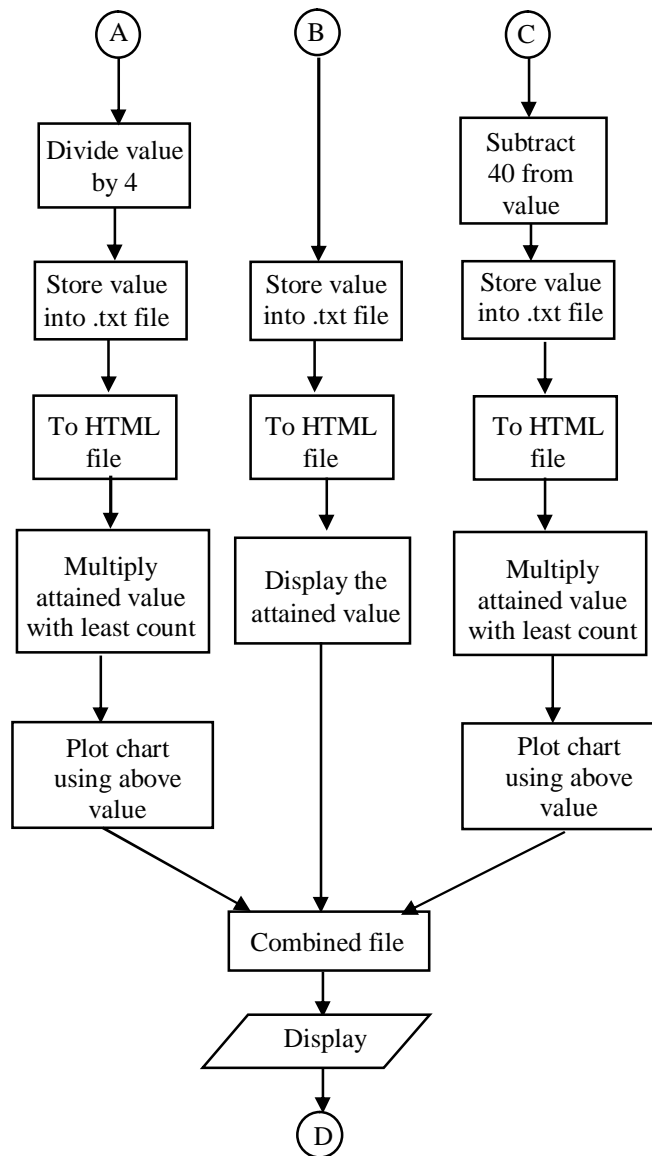
V.II FLOWCHART
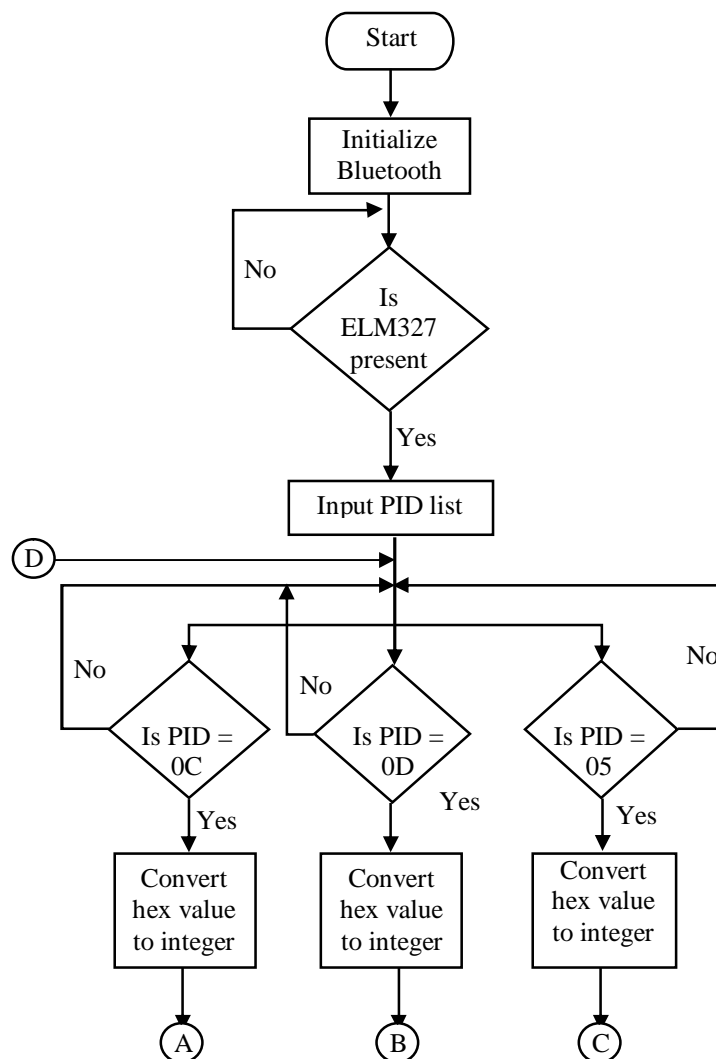
V.III. ALGORITHM

Step 1: Start

Step 2: Initialize Bluetooth

Step 3: Search for OBD II if found pair else keep on searching

Step 4: Send request for PID list and receive PID list

Step 5: Scan received PID list

Step 6: If PID=0C go to step 9 else go to step 5

Step 7: If PID=0D go to step 17 else go to step 5
Step 8: If PID=05 go to step 12 else go to step 5
Step 9: Convert hex value to integer value
Step 10: Divide value by 4 and go to step 13
Step 11: Convert hex value to integer value
Step 12: Subtract 40 from the value
Step 13: Store value into .txt file
Step 14: Move value stored in file into an HTML file
Step 15: Multiply attained value with least count
Step 16: Plot chart using attained value and go to step 21
Step 17: Convert hex value to integer value
Step 18: Store value into .txt file
Step 19: Move value stored in file into an HTML file
Step 20: Display the attained value and got to next step
Step 21: Generate a combined HTML file
Step 22: Project it to the windshield using a Pico projector.
Step 23: Go to step 5

From the algorithm it can be found out that the system works in a continuous loop.

VI. **RESULTS AND DISCUSSIONS**

System projects 3 values on to the windshield – speed, rpm and engine temperature. Speed is projected directly as a number while rpm and engine temperature is projected in the form of angular gauges. Sensor values are extracted from the OBD using corresponding Parameter ID's (PID's).

PID VALUE	SENSOR
05	Engine coolant temperature
0C	Engine RPM
0D	Vehicle speed

Table 1. PID values

Data's collected are used for generating the GUI and it is projected on to the windshield. Below image shows a snapshot of the GUI.
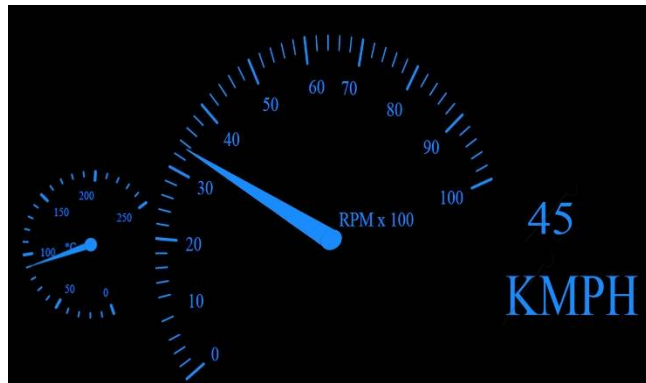
Figure 2. Real-time snapshot of the GUI

VII.   CONCLUSION

Proposed project is economical and reliable. It can be easily implemented into the automobile. Problem that arises with the system is the visibility at broad sunlight and the initial boot up time. But the application of transparent thin film provides better visibility, despite the boot up delay, the system works fine during real-time data capture. The system could also add navigational features and maps could be projected on to the windshield.

REFERENCES

[1]   Prasanth R, Aaradhana A Deshmukh, Bala Vignesh, Janani R, "An HUD for Connected Car for Maintenance and Emergency Intimation" , *IEEE International Conference On Recent Trends In Electronics Information Communication Technology*, May 20-21, 2016, India.

[2]   Oscar Alvear, Carlos T. Calafate, Juan-Carlos Cano, Pietro Manzoni "Validation of a Vehicle Emulation Platform Supporting OBD-II Communications",2015 *12th Annual IEEE Consumer Communications and Networking Conference (CCNC)*.

[3]   Anup Doshi, Shinko Yuanhsien Cheng, and Mohan Manubhai Trivedi, "A Novel Active Heads-Up Display for Driver Assistance", *IEEE Transactions On Systems, Man, And Cybernetics—Part B: Cybernetics*, Vol. 39, No. 1, February 2009.

[4]   S. M. Mahajan, Sudesh B. Khedkar, Sayali M. Kasav, "Head up Display Techniques in Cars*", International Journal of Engineering Science and Innovative Technology (IJESIT)* Volume 4, Issue 2, March 2015.

[5]   Engr. Leonard U. Ambata, Marc Carlo E. Lijauco, Christian Angelo C. Nuval , Richard Justin V. Vergara, "Distance Monitoring Vision System for Automobiles using Image Processing", *8th IEEE International Conference Humanoid, Nanotechnology, Information Techonology Communication and Control, Environment and Management (HNICEM)*.

[6]   Min Woo Park, Soon Ki Jung, "A Projector-based Full   Windshield HUD Simulator to Evaluate the Visualization Methods" ,*International Conference on Ubiquitous and Future Networks (ICUFN)*, March 2014.