Abstract: In modern vehicle, network buses are used to improve communication between ECUs and to reduce the wiring cost. Network buses, such as CAN, FlexRay have become the primary technique for sharing sensor data among control ECUs in the vehicle. On the other side, the Internet is becoming more and more popular, and has a growing user around the world. This paper focus on the method to link vehicle network with the internet, and also to portable device through which mobile developer and network expert has their way to develop application that has automobile into their context. WiFi has been chosen as the link between vehicle parameters to portable display device and to the internet, due to its high Bandwidth and well established technology in computer network. The primary objective of this project work is to develop both hardware device and software platforms for vehicle interface, and Hardware testing of the device using USB to CAN device as a vehicle CAN network simulation using Labview.

Keywords-CAN, Wi-Fi, Android operating system, LabView, GUI

I. INTRODUCTION

Today automobile industry is growing at a very faster rate. Each manufacturing industry is trying to make their vehicle smarter and comfortable than other. Every day new ideas are being explored and are tried to be implemented in real world. Due to this competition, vehicles are becoming more complex in design day by day. Therefore, there is need to reduce this complexity and it is achieved with Controller area network (CAN). In almost all vehicle CAN network is used for vehicular communication.

Over the last years, the technology for wireless communications has made tremendous advantages. It has high speed and maximum data transfer rate compared to Bluetooth. The field of information and communications technology is currently undergoing a fundamental transformation from the era of personal computers and wired Internet services to a new paradigm based on portable devices connecting wirelessly to the emerging mobile Internet. The mobile Internet represents the wireless revolution which started with remarkable adoption of Smart cellular phones.

A new and innovative way is use of wireless technology through smart phones and develop a user interface based on android operating system that will display vehicle operating conditions, diagnostics, controlling some parameters. The primary objective of the work is to develop both hardware and software platforms that directly communicate with CAN network and extract the system signal in the form of CAN messages and transfer it to Wi-Fi. The developed hardware is a circuit board that is capable of capturing CAN signals released from various sources within an vehicle. The Graphical User Interface is developed for smart phone that enables users to control certain functions of automobile via simple clicks of buttons. With the help of this developed application, it is possible to receive CAN message from the vehicle, display the same on smart phone and also control some of the functions. Thus for this purpose we have developed the wireless interface for vehicle which will connect controller area network (CAN) to Wi-Fi. Fig.1 illustrates the overall system description. CAN to Wi-Fi converter module send its signal over Wi-Fi and get received its signal by mobile phone.

Fig 1. System description

The remainder of this paper is organized as follows: Section 2 defines the background of the vehicle communication system. In this section CAN bus and Wi-Fi are explained in brief and their technical advantages are discussed for which these are selected among other various communication media. Section 3 explains working of the hardware used. Section 4 describes the simulation and implementation of project work.
II. BACKGROUND

This section gives overview of CAN and Wi-Fi technologies which are the backbone of vehicle communication system. This also explains the working principle of both.

A. Controller Area Network

In the early 1980s, engineers at Bosch evaluated existing serial bus systems regarding their possible use in passenger cars and found that none of the available network protocols were able to fulfil the requirements of the automotive. At the SAE (Society of Automotive Engineers) congress in Detroit, CAN was born in February of 1986. The new bus system developed by Bosch was introduced as ‘Automotive Serial Controller Area Network’. [7]

The growth of control systems in vehicle caused the growth of ECUs (Electronic Control Units) that require intercommunication. This intercommunication is achieved by networking technology known as CAN (Controller Area Network). Fig.2 illustrates typical intercommunication architecture in most vehicles today.

Fig 2. CAN bus architecture

In today’s vehicles, most of the ECU’s (Electronic control unit) are interconnected via the CAN bus. For example CAN bus connect different units of vehicle like Head light, dash board, antibrake system, Engine control etc. The structure of an ECU, is explained in Fig.3. It contains a Microcontroller and a network interface in the form of the CAN Controller and the CAN Transceiver. The Microcontroller is the central controller that contains the embedded control program, such as Engine control or Suspension control. The CAN Controller acts as the network interface. The function of CAN Controller is to extracts data from the Microcontroller and transferred to other ECU’s, and also puts that data into frames to be transferred across the CAN bus. The CAN Transceiver sets up the electrical signalling to transfer data across the CAN bus.

Fig 3. CAN structure in ECU

The CAN bus gets popular due to its following features:

- Multi master bus access protocol
- Message priority is provided by bus arbitration
- At multiple levels error detection and recovery is possible
- Separate clock sources are provided for synchronization of data timing across nodes

At the physical layer, differential data transmission is supported by the CAN protocol, which has advantages such as:

- Single pair of twisted cables with bidirectional communications
- It increases immunity to noise

B. Wi-Fi

Over the last few years, wireless market grows at a faster rate because of converting wire network world into wireless network world. Due to this complexity and cost of system is reducing. Wi-Fi (Wireless fidelity) is one of the wireless technologies. It is based on the IEEE 802.11 wireless local area network (WLAN) specification. The main goal of Wi-Fi technology is to provide wireless service for mobile computing device like laptop and mobile. But now a day’s Wi-Fi is used in all areas for example in vehicle wireless network is trying to use for vehicular communication.

Wi-Fi includes IEEE 802.11a/b/g standards for wireless local area networks (WLAN). It allows users to surf the Internet at broadband speeds. It may be connected to an access point (AP) or in direct mode. Wi-Fi in mobile has both mode according to API levels. In direct mode there is no access point, communication take place from one device to other directly as shown in Fig 4. Wi-Fi in
android works on API level 8 and above up to API level 14. Whereas Wi-Fi direct operate on API level 14 and above.

Wi-Fi products can operate on different radio frequencies. The 802.11a standard uses 5 GHz in an AP-to-AP interlink. The 802.11b and 802.11g standards use 2.4 GHz. Different frequency bands are used by the 802.11a, 802.11b and 802.11g standards; Different devices using these different frequency bands do not interfere with one another. The 802.11b and 802.11g are most commonly used standard in the Wireless LAN because of their interoperability and operate in the frequency range of 2.4-GHz band.

Smartphone are quickly becoming the main computing and data communication platform. Now a day, All Smartphones are equipped with Wi-Fi, Bluetooth. Table 1 is the comparison table between Wi-Fi and Bluetooth.

III. HARDWARE DESCRIPTION

This section describes the overall system design and requires circuit board. This gives complete idea of how the hardware is working.

A. Overall System Design

As shown in fig.5, it is proposed to design an interface which will connect vehicle control area network to internet through Wi-Fi. For development of vehicle communication interface, it will require a CAN transceiver; CAN controller, Microcontroller and Wi-Fi transceiver module.

![Fig 4. Modes of Wi-Fi](image)

From below table1, it gets clear that Wi-Fi is better than Bluetooth. Hence we decided to design the interface for CAN to Wi-Fi.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Wi-Fi</th>
<th>Bluetooth</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE spec.</td>
<td>802.11a/b/g</td>
<td>802.15.1</td>
</tr>
<tr>
<td>Frequency band</td>
<td>2.4 GHz; 5 GHz</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>Max signal rate</td>
<td>54 Mb/s</td>
<td>1 Mb/s</td>
</tr>
<tr>
<td>Nominal range</td>
<td>100 m</td>
<td>10 m</td>
</tr>
</tbody>
</table>

![Fig 5. General block diagram of working flow](image)

CAN transceiver receive the messages from CAN of vehicle and send it to CAN controller. CAN controller send its signal to the microcontroller. With help of USART and SPI it communicates to USB transceiver and Wi-Fi Transceiver module. Now these signals transmit over internet and display on android phone.

B. Circuit Boards

In Fig 6, snapshot of the developed hardware is shown. In this hardware, CAN transceiver and Wi-Fi transceiver are the important chipset.
In this work we use MCP 2551, Pic18f board, RS232 and serial to Wi-Fi converter chip.

Fig 7 describes working flow diagram of the developed hardware. In this section the significance of above ICs are describe in brief. The MCP2551 is a high-speed CAN transceiver IC. It serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 has transmit as well as receive capability for the CAN protocol controller and is fully compatible with the ISO-11898 standard, including 24V requirements. This is required because the pic 18f board which we used does not have CAN interface directly. The pic 18f board receive these CAN signal. After programming this pic 18f in MP lab we transfer this signal to RS232. The Wi-Fi transceiver receives this serial signal and transfers it over Wi-Fi. Ultimately in mobile these signals are received. This is the bidirectional communication.

IV. HIL’SIMULATION AND IMPLEMENTATION

A. HIL Simulation

Simulation or we can say testing of any hardware in virtual environment is necessary. To test the hardware on vehicle directly is very risky and dangerous. The developed interface is simulated and tested in LabVIEW.

Following fig. 8 is the snap shot of front panel in LabVIEW for HIL testing in Lab. On this panel we test some parameters of vehicle that are Auto start on/off, Neutral gear, Operating mode and some controlling parameters like power window up/down, AC control. The CAN messages are received from PCAN of NI-USB. These signals are received by Computer and it will operate according to receive messages.

On software side, we developed an application in android mobile. With only some click on button we are able to operate some parameter of vehicle. The snapshot of GUI application development is shown in fig. 9.

B. Implementation

After testing on virtual environment, the interface is tested on vehicle with the help of GUI that is developed in mobile. We obtained the successful result of testing on vehicle. It is implemented on one particular vehicle. It is in progress to implement on vehicle in production point of view.
V. CONCLUSION

This paper describes an idea about the interface for vehicle communication with the help of CAN & Wi-Fi controlling modules. This method will help to reduce cost of wiring harness within the vehicle systems for data communication. This application will help to make vehicle most attractive and comfortable.

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