A Review on Design And Development of Vehicle Body Controller

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Abstract- *This paper deals with review for designing and developing body controller module in automotive background. This study is associated with various areas. The review on development boards having onboard controller with inbuilt CAN interface and Bluetooth low energy module along with components like sensors, actuators, current drivers & signal conditioning circuits are achieved. The developed system will be tested by making a prototype for the same.*

Keywords- Body Control Module (BCM), connectivity, microcontroller, Electronics Control Unit (ECU), embedded systems, Internet of Things, Bluetooth, Wireless Communication Technology.

I. INTRODUCTION

There is increase in demand for dynamically controlled safety features, passenger comfort, safety critical indications and operational convenience in automobiles which require an extensive use of electronic components.

In order to meet these expectations, more number of sensors and controlling circuitry are being used in vehicles. Vehicle electronic devices include vehicle information systems, vehicle dynamics controllers, electric window lifters, and auto levelling headlights etc. which are controlled by their corresponding controllers or switches.

The requirements for this is increasing day-by-day. But this de-centralized control will become highly complex, will have more timing issues, data losses and will get more and more difficult to achieve synchronization. The increasing need for information sharing, synergy, and cooperation among various devices demands for a simpler setup as provided by a centralized control module. The Body Control Module (BCM) that will be developed as a part of this development demonstrates the use of the centralized control module architecture.

A. Embedded Systems

An embedded system is an electronic or computer system used for controlling and accessing data based on electronic systems. Embedded system includes CPUs including cortex, ARM and also microprocessors, FPGAs, DSPs, and ASICs. Nowadays the usage of embedded systems is widespread.

An advanced embedded system in automobiles has been increasing rapidly in the past two decades. Yearly automobile manufacturers integrate embedded systems into their cars for different functionalities like ignition, security and anti-lock braking systems. The technological innovations of the embedded system within the vehicle are quite challenging to make the vehicle energy efficient and safer. In 1968, the Volkswagen used first embedded system in the automobile industry. [1]

In automotive systems many integrated components are being changed from the mechanical systems to electronic systems. Embedded system plays a vital role in vehicle's electronic system because of its versatility and flexibility. The revolution of electronics has been a boon for automotive design including the fuel combustion, power train crash protection, etc. [2]

B. Wireless Communication Technology

The wireless term literally means the communication or transmission of information over a distance without wiring harness. Wireless communication is one of the important mediums of transmission of data or information to other devices. The information is transmitted through the air by using electromagnetic waves like radio frequencies, infrared, satellite, etc., in a wireless communication technology network.

Today, wireless technology is associated with smart phones, laptops, tabs, computers, printers, Bluetooth, etc. Recently wireless communication technology has become a main part of several types of communication devices as it allows users to communicate even from remote areas. [3]

There are many products for wireless technologies that can be implemented in hardware products for the Internet

of Things (IoT) and Machine to Machine (M2M) communication.

C. Internet of Things

Devices and objects with inbuilt sensors are connected to an Internet of Things platform this integrates data from the different devices and applies analytics to share the most valuable information. These applications are built to address specific needs. [4]

These powerful IoT platforms can detect exactly what information is useful and what can be ignored. Smart objects and systems are actually those which you can automate certain tasks, particularly when these are repetitive, mundane, time-consuming or even dangerous.

II. TOPIC OF STUDY

A. IEEE 802.15.1 Bluetooth and BLE

Bluetooth and Bluetooth Low Energy (BLE) are wireless communication technologies for transfer of data to a short distance. This technology is used frequently in phones and tablets. Bluetooth Low Energy uses low power than Bluetooth Standard. [5]

BLE has developed a lot nowadays. The technology was initially introduced by smartphone maker Nokia in 2006, but didn't become part of Bluetooth standard until 2010. Today, BLE, which is also called Bluetooth Smart, is supported by the majority of smartphone and computer makers including operating systems such as Windows 8, OS X, Linux, Windows Phone, Android and iOS.

BLE transfers data packets (8 octet minimum up to 27 octets maximum) with 1 Mbps speed. Energy consumption are kept at minimum level controlling low duty cycles. Bluetooth technology minimizes interference from other technologies in the 2.4 GHz ISM Band. Efficient multi-path increases link budgets and is effective for operating range and energy consumption.

BLE has significant amount of intelligence in the controller. This allows the host to sleep for longer periods of time and be woken up by the controller only when the host needs to perform some action. Thus current savings are more and power consumption levels are low.

BLE supports connection setup and transfers data in approximately 3 ms. This enables an application to establish a connection and transfer authenticated data in just a few milliseconds for a short communication. Modulation index increases the range of BLE to over 100 meters. BLE uses a strong 24-bit CRC on all packets to ensure the maximum robustness against interference.

B. Automotive IoT

Vehicles are becoming more intelligent with each generation has a boon with Internet of things. As vehicles continue to become more autonomous, sensors will play an increasingly critical role alongside cameras in enabling functions like lane departure warnings, parking assistance, and automatic braking. Data processing has never been easier in cars. With advanced driver assistance systems (ADAS), infotainment systems, and V2V communications, vehicles need to collect, analyze, and also share data in real time.

C. Body Electronics

Modern vehicles contain a wide range of systems that provide control functions, implement diagnostics and safety features, and manage power. Today we have a wide array of power switching and monitoring circuits, sensors, and sensor interface and communication ICs for automobile body electronics. CAN fieldbus plays a vital role in all of these. [6]

Motor vehicles are equipped with an increasing number of functions, making automotive electronics more complex. Increasing vehicle functionality means that more and more electric and electronic ancillaries are fitted. More power is required, and there is more load on the battery. Therefore, energy management and reliable state-of-charge monitoring are becoming even more important. [7]

III. LITERATURE REVIEW

The literature survey is carried out to know the state-of-the-art in applications of automobile industry and other allied areas. Studied literature is organized into various parts i.e. engine control unit, body control module, CAN bus, connectivity protocols – BLE, GSM.

The author has given an overview of body control module using PIC micro-controller in the automotive industry and also illustrates some controlling features that are associated with the car body controlling requirements and proposes some future directions, in particular with respect to diagnostics.[8]

This paper presents a CAN protocol using a bus analyzer system. [9] This also defines various inter-connection of Electronic Control Unit and their communication as engine

speed, intake manifold pressure, etc. But it required to properly implement in automotive industry which is having such huge number of parameters to sense, process and display.

Here the team of this paper have designed a system to detect Engine operation condition. They have used programmable system on-chip design to build electronic control unit. [10]

Electronic control unit along with security protocols and its architectures are defined. Security protocols are elaborated with architectures which makes a clear understanding. Thus inter-ECU communication is established using these security protocols. AES encryption features are also defined. [11]

IV. SCOPE OF CONTRIBUTION

This project will offer a complete range of gateways between LIN and CAN networks and Body Control Modules (BCM), from the simplest solutions to the most complex ones. In order to satisfy our customers' needs pertaining to functional contents, price and time-to-market, we will develop a central control unit along with mobile connectivity that allows perfect integration

D. Design and reliability

Automotive design has always been a challenging task according to ECU specifications, wide temperature ranges, high-quality, reliability requirements and low costs. Today's designs also need to be flexible, upgradeable, and easy to test fully. There is big demand of cars and automotive industry is developing widely so it is important to make automotive products safe and comfortable with effective usage of advance technology.

E. Wired to wireless transformation

Industry is running on few hard core things from long-long time and now there is a time to change that in order to make vehicle more safe and comfortable. In one way wired architecture makes automotive design complex and tough and in another, we cannot be with wired communication due to various drawbacks for long and hence we need to find out some feasible solution for automotive world. This study is about the few possible wireless communication media and is specific to wireless body control module that deals with Power Window, Climate Control, Engine on-off, wiper etc. kind of vehicle function in an automotive product.

F. Wireless protocols

There are variety of wireless protocols available now a days, so we need consider the basic need of an automotive product like, limited range of communication, effectiveness for the vehicle, cost effective. There also exists the need to handle the interference and noise. In current analysis we tried to compare and study protocol like Wi-Fi, Bluetooth and ZigBee in order to find the best and Bluetooth has advantage over all of them. Wireless BCM can also be designed using ZigBee without having any problem if we don't have Bluetooth in car. There is big impact of location of Bluetooth on ZigBee communication.

V. CONCLUSION

The study covers a wide area for a review on vehicle body controller. The contribution in all these areas is significant. The system developed with the integration of all these area finds to be with automotive grade quality. The wireless technology developed is similar with recent models but used with effective and economical perspective.

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