Design of Hardware Module for the Vehicle Condition Monitoring System Based on the Internet of Things

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Abstract. One problem in the development stage of driverless cars on public roads is how to monitor the condition of the vehicle that is affected by different weather and environment, including dry, snowy or heavy rain conditions, which are sometimes difficult to predict and require monitoring systems that should be real-time and accurate. For this reason, an internet of things-based car condition monitoring system is needed to be developed. The development covers three essential parts, which include the development of hardware and digital communication modules, web server development and data analysis and mobile application development for monitoring. The purpose of this study is to design a hardware module needed for car vehicle condition monitoring system; a prototype completed with the onboard diagnostic module and embedded system that will send data to the server in real time. The system was successfully designed and developed using ELM327 and ESP32 with SIM808 for communication module. The benefits of this research are as a tool for asset management of car vehicles both for personal and corporate needs. This study also supports the development of driverless cars that require real-time data input between the vehicle and the server.

1. Introduction

In implementing industry 4.0, the main supporting factor is the availability of digital infrastructure; one of them is the internet of things (IoT). IoT refers to a network of physical devices, vehicles, household appliances, and other items planted with electronic devices, software, sensors, actuators, and connectivity that make it possible to connect to the internet network and collect and exchange data.

Over time, cars are an indispensable asset to move safely and comfortably. The intensity of the use of private vehicles, primarily cars, as a means of transportation in everyday life is increasing. Monitoring and maintenance are essential to maintain user performance and comfort. Thus, it is necessary to use technology to support this, one of which is the use of Internet of Things (IoT) -based technology.

On the other hand, automotive manufacturers are working to develop unmanned car technology (driverless car), the vehicles that will no longer require drivers because the function has been taken over by artificial intelligent systems (AI). Now one of the technology producers from the United
States, Alphabet Inc's Waymo under the auspices of Google, will soon launch a shuttle vehicle service without humans behind the wheel. One obstacle that arises in the testing phase on public roads is the condition of various terrain affected by different weather and environment, including dry, snowy or heavy rain conditions which are sometimes difficult to predict and require real-time and accurate monitoring system. For this reason, an internet of things-based car condition monitoring system is needed to develop the driverless car.

Previous research shows the possibility of these purposes. Expert researchers have proven successful work in the field of wireless networks and smart systems such as the open garden sensor [1], water billing system [2], person locator tracking system [3], integrated smart plug [4], solar radiation monitoring [5], waste transport monitoring [6], pollution monitoring system [7], power meter monitoring [8], and water pollution monitoring system [9]. Srinivasan and others also proposed an IoT cloud-based real-time automobile monitoring system that utilized all possible IoT solution to monitor the vehicle [10].

The purpose of this study is to design and develop hardware module needed for car vehicle condition monitoring system prototype complete with ion board diagnostic module that sends data to the server in real time.

2. Material and Methods

The system was designed by using the receiving device and data processor for the reading of machine data from OBD devices by adding RTC modules and GPS to get data accurately in time and place, then the data can be stored in the Micro SD memory card and sent to the database server using the GPRS module. The existing data, both in SD memory and database, is then processed using programs to do data display in real time, as well as in-depth analysis to obtain patterns of changes and predictions of future engine performance.

The results of the analysis obtained from existing data are used for reference to predict when the engine needs to be maintained or predict when the engine components must be replaced so that it can prevent damage to the car while traveling. Data that is already in the database will be displayed on a website page built with a programming language. Because data processing is on the server so that it can be accessed using a variety of smart devices such as PCs or smartphones.

For this design to run correctly and directed, the steps taken to make the system are as follows:

2.1. System Design

At this stage, the system model of diagnostic data reading was made from the machine so that the description of the system requirements was designed, in both hardware and software simultaneously.

2.2. Design of hardware modules and data processing

At this stage, the data reader system design and integration of the hardware used in the design are carried out. The design of this device refers to ESP32 as a microcontroller.

2.3. Server and Website Configuration and monitoring

At this stage, the configuration is done by configuring the web server and database server. After the server has been configured, then the system that has been built is stored on the server so that the system can run online and be accessed by users using the internet.

The following figure shows a picture of a block diagram and a series of systems that want to be developed: consisting of an integrated internet system (IoT System), a system for reading data from ECU and a data communication system.
3. Results and Discussion

The hardware module developed consists of an onboard diagnostic unit or known as OBD. OBD is an automotive term that refers to the ability to diagnose a system on a vehicle. The OBD system provides reports on vehicle status to vehicle owners or technicians. Furthermore, a series of low-cost and low-power microcontroller systems will be developed with integrated Wi-Fi and dual Bluetooth modes. Whereas for communication modules, a complete Quad-Band GSM / GPRS module is used, which combines GPS technology for satellite navigation.

3.1 On-Board Diagnostic (OBD)
OBD is an automotive term that refers to the ability to diagnose a system on a vehicle. The OBD system provides reports on vehicle status to vehicle owners or technicians. OBD connected directly to the Electronic Control Unit of the car. The following figure 2 is ELM37 as one type of OBD

3.2 Processor Module
For the processor, ESP32 was used. ESP32 is a series of low-cost and low-power microcontroller systems on chips with integrated Wi-Fi and dual Bluetooth mode. The following figure 3 is a type of ESP32
3.3 Communication Module
SIM808 is a complete Quad-Band GSM / GPRS module that combines GPS technology for satellite navigation. Together with the external Micro SD for storage and clock timer RTC, it built as a communication module. The following figure 4 is a type of SIM808.

![Figure 4. SIM 808](image)

3.4 Integrated Design for Hardware Module
The final step of the design stage was to integrate the whole components into a hardware module system as designed. The following figure 5 shows the hardware design and digital communication module that will be developed. And figure 6 shows the prototype design planned for the hardware module.

![Figure 5. Hardware design with a communication module](image)

![Figure 6. A prototype of the hardware module](image)
4. Conclusions

We have successfully designed a hardware module for vehicle monitoring system based on IoT. The hardware module developed consists of an onboard diagnostic unit or known as OBD. OBD is an automotive term that refers to the ability to diagnose a system on a vehicle. The OBD system provides reports on vehicle status to vehicle owners or technicians. Furthermore, a series of low-cost and low-power microcontroller systems will be developed with integrated Wi-Fi and dual Bluetooth modes. Whereas for communication modules, a complete Quad-Band GSM / GPRS module is used, which combines GPS technology for satellite navigation.

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