Intelligent Vehicle Diagnostic System for Service Center using OBD-II and IoT

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Abstract- *Vehicles are an essential source for traveling around the world. It is vital to keep the vehicles maintained well. We were proposing subscription-based vehicle maintenance solutions for the people who do not have the time for the repair and maintenance of his/her vehicles. An IoT device will be connected to the OBD II Slot of the vehicles, send all diagnostic data to a server, and notify the customer through a mobile application about the vehicle status if a customer wants to repair or do regular maintenance. The proposed system will send a request to all the dealers and repair shops nearby to get a quotation, availabilities of parts, and estimates the time of completion (ETC). Then, the customer can choose where he wants to repair it. Through the app, customers can request roadside assistance, vehicle recovery, and loaner vehicles.*

Keywords: Service Center, Vehicle Malfunction, OBD-II, Artificial intelligent, IoT

I. INTRODUCTION

Vehicles are having very complex structures need a well-thought-out maintenance plan. More safety packages are currently added to modern vehicles, so many sensors and actuators are used. Predictive maintenance, corrective maintenance, and preventive maintenance are mandatory as modern vehicles have complex systems.

According to a statistics (*World Vehicle Population,2016*), the total population of the vehicle in the world will be doubled in every 20 years. More than two billion vehicles were on the road at the end of 2016, increasing over eightfold in the last two decades from 670 million in 1996. Coincidentally, it grew at roughly the same rate from 1976 to 1996, increasing by over 342 million. That study predicts we'll that roughly 2.8 billion cars on the planet by the year 2036.
Based on the survey mentioned above, vehicle usage is increasing rapidly and the accident too. The need for maintaining vehicles is essential in this era. Most road accidents are happening because of vehicle errors and bad vehicle maintenance. It will be challenging to find a repairing center while getting repair in the middle of traveling. These kinds of problems have to be solved quickly. We proposed AI-based Service Centers for those traveling long far. The transportation chip will send the erroneous code to our server through the vehicles' On-Board Diagnostics II (OBD II) system. The system will send the request to the nearest Service Center with the error report. Our app will notify the client about the error and the nearest Service Center for the repair. If the client accepts, the repair system will request the Service Center to get an appointment quickly, or the client will choose a mobile repair service.

II. RELATED WORK

Bartosz Kowalik said that On-Board Diagnostics (OBD) is utilized for diagnostic purposes in the new car. OBD is used to read car parameters and also collect diagnostic data of the vehicle. But preventing gasket failure is impossible based on gathered data from the car's diagnostic interface. While the eventual crash was_unavoidable, some data can be used to develop a detection system for future malfunctions. Lots of information were already available for implementing ecological solutions for cars with traditional engines (Kowalik, 2018).

Balázs Bánhelyi and Tamás Szabó said every new has an OBDII port that can be utilized to get vehicle diagnostic data with fault detection. They have developed an application and set of parameters that measure those observations and algorithms, which perform relevant analysis on the resulting data and figures to verify whether they are correct. Their system can detect rare data, and if the data appear, users can be alerted (Bánhelyi and Szabó, 2020).

Kavian Khorsravini and his colleagues predict that the number of internet-connected electric vehicles will increase in the near future. Growth is being supported for the monitoring, controlling, and following of electric vehicles with new technologies. Until now, no distinct system has been built to incorporate all these disparate elements into a single package. They created a controller area network that communicates with On-Board Diagnostics through the Electric Vehicle diagnostics. Signals that are both interesting and useful are found through the monitoring of the CAN bus protocol IDs. In planning, it's possible to implement the new CAN (Controller Area Network) diagnostic in the vehicle system. There are numerous new vehicle-access features available in their mobile application (Khorsravinia *et al.*, 2017).

The researcher's Chin Lin and others developed a diagnostic system using On-Board Diagnostics (OBD) to detect system issues and alert the driver. In almost all cases, the operators usually will not make any change. Their paper introduces a new system with real-time vehicle condition acquisition and transmission through GPRS mobile phone to the On-Board Diagnostics using the internet to a Server of Maintenance Center (SMC). Implementation of an Online Diagnostics and Early Warnings system for vehicles can allow the Internet of Things to provide diagnostic and warning in real-time This paper's design and system verification phases could successfully route the DTC. on the report findings, the auto service department will offer repairs as a service (Lin *et al.*, 2005).

Another study was conducted by J V Moniaga and et al. using Raspberry Pi and iSaddle Bluetooth OBD-II tools to store and analyze the vehicle diagnostics data from the OBD-II port. Individuals can also communicate their vehicle to control (Moniaga *et al.*, 2018).

Siddhanta Kumar Singh and et al. developed intelligent diagnostic systems via deploying an IoT device in the automotive sector to avoid the road accident rate. They mentioned in the study that the internal problem of the vehicle is also one of the reasons for a road accident. To solve the issues mentioned above, they suggested a solution based on the OBD-II port of the vehicle is connected to an IoT system (Raspberry pi and Nano Bluetooth Dongle) and smartphone (Singh, Singh and Sharma, 2021).

Uferah Shafi and her colleagues are investigating vehicle remote vehicle health monitoring and predictive maintenance techniques, which allow repair centers to replace components before they fail. A methodology for identifying faults of the four major subsystems of a vehicle is described in that post: vehicle propulsion, fuel system, ignition system, exhaust system, and cooling system; this study connects the car's on-the-board diagnostic port to an IoT device to gather diagnostic data (Shafi *et al.*, 2018).

III. METHODOLOGY

For the time of repair, the client has to go to the service center, and after the repair technician needs to connect the On-Board Diagnostics II (OBDII) scan tool and need to find the problem. This client has to wait sometime to repair his vehicle. It is time-consuming work for those who are spending their valuable time on their work.

A. On-Board Diagnostic II

In almost every type of vehicle engine, OBD II is part of the On-Board Diagnostics. Continuous emission performance monitoring uses data from sensors to judge how well emission controls are working (Sensors do not directly measure emissions). Currently, the on-board diagnostics systems have been configured to help monitor the powertrain and its emission-control systems for the possibility of system failure and deterioration at all times while in use.

The general requirements for OBD II are:

- Virtually all emission control systems must be evaluated.
- We will have to identify potential malfunctions before exceeding regulatory limits (generally 1.5 X emission standard).
- On average, failures should be found within two cycles of the first one completed drive of use.

A problem that can lead to an increase in air emission is identified, the Malfunction Indicator Light (MIL) lights on the dashboard to warn the driver. Can detect various vehicle systems by plugging into the standardized connector, then they can use the scan tool to connect to the Diagnostics and Data Link connector (DCL). (Lyons, 2015).

OBD II vehicles can provide three pieces of information via a scan tool:

- The ON or OFF setting of the Malfunction Indicator Light.
- What diagnostic error codes (DTCs) are stored.

- The condition of the loggings.

B. Malfunction Indicator Light

The instrument panel will illuminate a warning light when there is a malfunction. (Lyons, 2015).

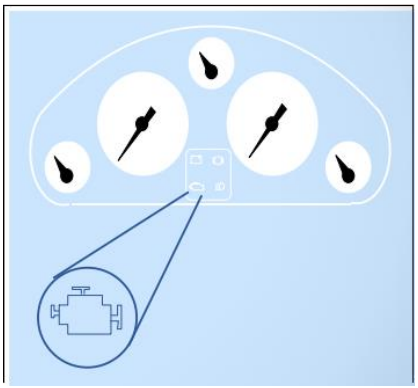

Figure 1. Malfunction Indicator Light (MIL)

C. Bluetooth OBD 2 Scanner

It is necessary to have a thorough knowledge of the OBD2 protocols and convert them to the standard PC serial data. While OBD-II is more practical for our current conditions, we could implement Bluetooth PDLS in the future. Only approved protocols for Bluetooth OBD-II readers can be used with Bluetooth OBD-II Scanners. Moreover, the wireless OBD-II scanner requires no wires, nor does it need batteries.

Figure 2: Bluetooth OBD 2 Scanner

D. Proposed System

While the repairing task, the client has to go to the service center, and after the repair technician needs to connect the On-Board Diagnostics II (OBDII) scan tool and find the problem. As discussed earlier, the client has to wait sometime to repair his/her vehicle. It is a time consume work. Generally, in the service center, the technician uses an OBD II scanner to find the diagnostic in the vehicle, but that diagnostic scanner is not needed here. Already plugged in, the scanner will send the diagnostic data to the mobile, and the installed mobile app will send the diagnostic data to the server. The Bluetooth OBD II scanner has to plug into OBD II port to read all of the vehicles' diagnostic code detail and send the data to the mobile application. If the internet is available, the mobile application will send those diagnostic codes to the server. If not, the application will send the data to the server once it gets the internet.

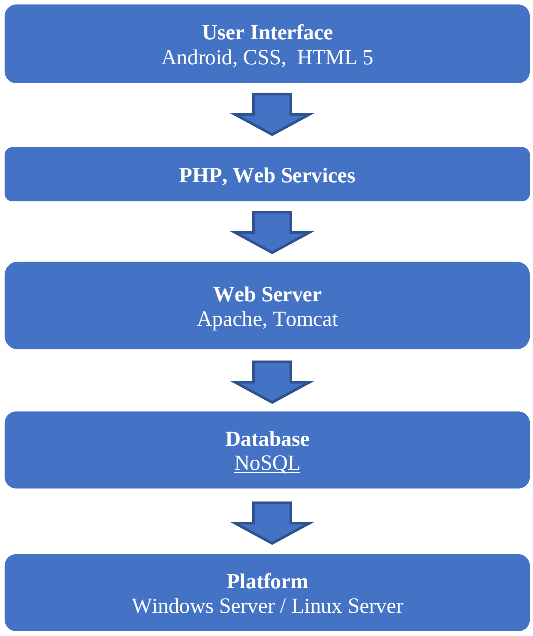

Figure 3: Technology Stack for the proposed system

The technology infrastructure illustrated in figure 3 encompasses the processes of AI development and deployment. The server will connect to the mobile application through the internet, and once the server gets diagnostic data from the mobile application, it will start responding to that request. When the server receives the diagnostic data, it will analyze the diagnostic level. The server will access the mobile devices' Global Positioning System (GPS). The server will search the nearest service center to fix the issue using the mobile device's GPS. If it finds the nearest service center, the server will send the diagnostic data to that Service Center and request time availability. Once it sent the data to the service center also alerts the user. The server will send a request about the malfunction and notify the user.

Once the server sends the request to the user, the mobile application will convey that to the user. For the user, the application will show the malfunction detail category-wise. There are two types of categories here it will mention.

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- Critical
- Intermediate

Critical kinds of malfunctions have to repair immediately. The server will automatically send a request to the service center for these kinds of malfunctions and get an appointment to repair the vehicle. The server will mention to the technician that "critical issue need to repair immediately". Then the user just has to go to the service center. And it will display the maximum suitable time to fix this. Users can request another convenient time from the appointed service center once the user cannot reach the service center at the correct time. This user has to pay an additional mobile charge.

For the intermediate kinds of malfunction, the server will automatically send a request to the service center and ask for an appointment to repair the vehicle. But, nothing will be mentioned, and the user can cancel the appointment. The technician can give the appointment for repair depend on the malfunction. If it is a critical malfunction, the technician has to provide the most recent suitable time. If he doesn't have the time, he can cancel the order or transfer to another service center. When the server does not respond to the requested technician, the server will request another service center.

E. The tools and technology suggested for developing the proposed system

If you want to run more than one NoSQL instance for different purposes, use an open-source like Cassandra to serve multiple databases. Apache web server: Apache on top of a Windows server to provide websites, databases, and business applications. Like UNIX, Linux is a Unix-like operating system that Like UNIX, Linux is a Unix-like operating system available under open source and free software development. A software operating system designed for handheld devices such as tablets and smartphones runs Google's Android OS. The software was developed by the Open Alliance, a group of Google developers. Android app development is helped along by a group of specialized software development kits (SDKs). An HTML was the world's first software language for the Web; it provides a standard way to structurally and presentational lay out and present web content. PHP was originally developed for web development and is still very useful for it today. If you use this script to design your mark-up document, you'll have to describe the presentation semantics in a second script called cascading style sheets. (Desai and Kallaganiger, 2013).

A figure to illustrate the overall architecture of the AI-Based Service Center is shown in the above diagram. The technology stack, user profiles, and means for accessing the application are all aspects of the solution. Explanations of these aspects are covered in depth in the following. This system contains mainly three actors that use AI in their services.

- Administrator
- User
- Service center

A native Android Service Center app will be employed by the user and service center to improve user satisfaction by providing direct access to application settings and features. The data from OBDII will be acquired by using Bluetooth by Service Center Application.

The Service Center system has five main subsystems, and they are 1. Admin Subsystem, 2. User Subsystem, 3. Service Center Subsystem, 4. OBD 2 Code Reader, 5. Core Logic Subsystem. And the Administrator will have the following functionalities: Admin can update/delete the information about the user and service center, the admin will have also handled the escalation mechanism, admin can record the feedbacks given by the user and service center, and admin can update/delete OBD 2 readings.

At the same time, the user will have the following functionalities: Users can view the malfunction detail about the vehicle, cancel the appointment of the service center, view the service center location via Service center application, apply for additional appointments for other services, will get the appointment details by the service center from Service center application, view the distance and route path from his/her current location to the destination and view the repair cost with additional service charges.

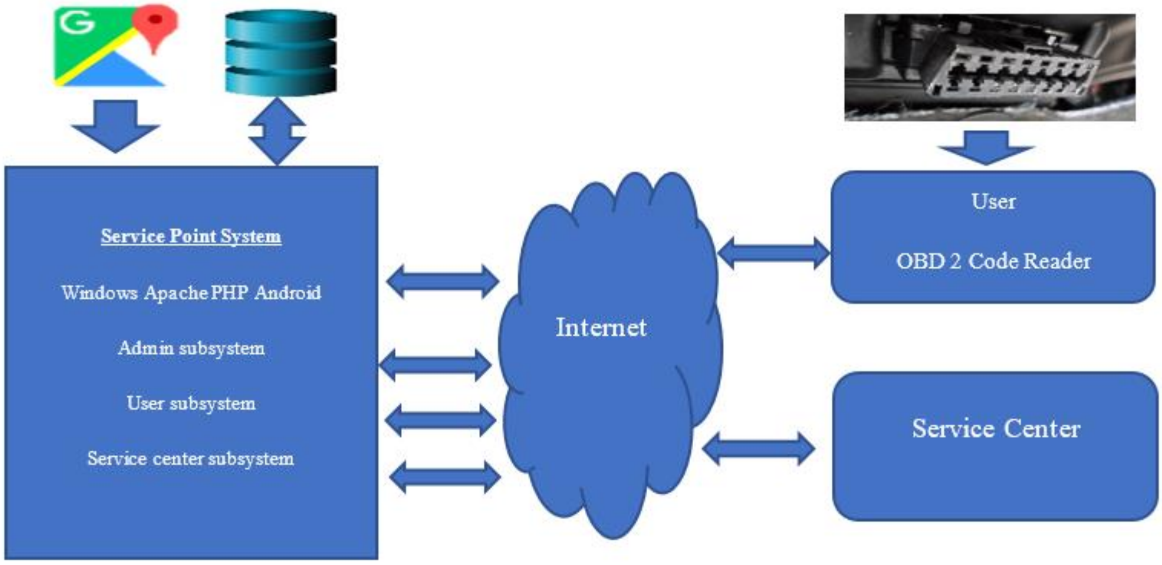

Figure 4: The Architecture of the proposed system.

The service center will have the following functionalities: Giving an appointment for the user, cancel the appointment, can view the malfunction detail, and can view the distance and route path from the service center location. And the OBD 2 Code Reader responsibilities such that, Read the code coming from the OBD 2 scanner and identify the malfunction and categorize the malfunction.

Finally, the Core logic subsystems are responsible for all the operations in the system. It handles all the requests from the clients. It works on IIS / Apache webserver, has all the web services needed to serve client requests, is implemented using PHP, receives data from the database, and sends it to the client. In addition, the system has the functionality to manually find the nearest Service Center and make an appointment. Users can get to know their vehicle's condition at any time.

IV. CONCLUSION

A system presented in this paper has full functionality with a single need concept of Service Center according to the current scenario of common vehicle errors. This system will help the people who do not have the time to maintain their vehicles. Significantly, the women can get full of help from this system. The suggested system is built using freely available tools and techniques. The proposed system may upgrade with new features such as fuelling, medical emergency, and self-defense in the future.

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