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Survey of Smartphone applications based on OBD-II for Intelligent Transportation Systems

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ABSTRACT
Highway transportation is supported with several technologies to decrease risk factors and to obtain secure drive. With improved software and hardware smartphone technology is able to monitor the useful information from information network and especially it helps to maintain and control better traffic management for ITS. In this study accession systems to electronic control unit are examined and also access procedure to vehicle status via onboard diagnostic (OBD) also demonstrated. Additionally vehicle and environment information evaluation and prevention of accident risks with smartphone technology are also indicated.
***Keywords* -** Intelligent Transportation Systems, Smartphone, OBD-II, Driver Information, Traffic

I. INTRODUCTION

Intelligent Transportation Systems (ITS) contains the solutions developed for removing the traffic problems [1]. Parallel to the developments in automotive technology, systems like ITS cameras, road sensors, variable message systems, mobile information systems, signalization systems and similar applications based on the usage of transportation regulation and guidance of electronics and computer technologies are being supported by different systems [2, 3, 4]. Systems like Vehicle Information and Communication Systems (VICS), local traffic information systems, roadside units and on-board antennas, Electronic Toll Collection (ETC) and GPS-enabled cellular phones can be exemplified [5].

The information and control technologies forms the substructure of Intelligent Transportation Systems however, very complex situation must be evaluated because of the vital importance and human factor. Therefore, for a professional accession with AUS technologies, AUS equipment and facilities should always include the human factor [6]. The newly developing mobile devices support wireless communication technologies, data communication standards, and GPS technology. Vehicle communication based on the software and hardware flexibility on the smart phones allows viewing the useful information such as road traffic status, traffic accident, delays or other accidents and particularly provides a better traffic management and inspection for AUS [7].

Vehicle status information can be transmitted to drivers while driving by using an appropriate interface with smart phones that provides high calculation speed and wireless communication facility [8]. Access to ECU of vehicle is performed via OBD. OBD-II provides access to vehicle’s data network can bus as a standard extended by SAE. There are a lot of OBD-II device designed by using OBD-II protocols to monitor vehicle data network. Combination of OBD and wireless technologies monitoring and control applications of mobile devices has been emphasized [9].

In this study smartphone applications which access to vehicle ECU data are studied. Methods of access to vehicle data via mobile device explained and systems providing solutions to traffic problems by using these methods evaluated.

II. METHODS OF ACCESS TO VEHICLE DATA VIA MOBILE DEVICE

Gathering information, inform the driver about vehicle and tracking error code proecesses can be performed easily with OBD technology [10]. Access to ECU data with mobile devices of the drivers is performed by diagnostic device connected to OBD-II connector. OBD-II device that enables the export of data on the CAN-Bus undertook the converter task [11]. Smartphone access to ECU data by providing a connection with diagnostic device. Thus, the driver can monitor the vehicle data in real time via smartphone.

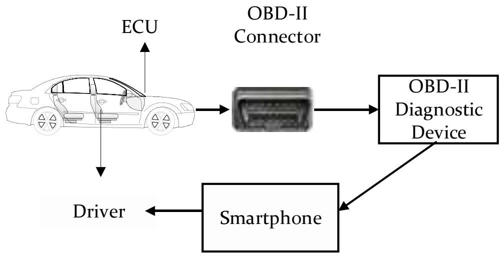

Figure 1. System structure

OBD-II diagnostic devices are being producted by the wireless communication technology with Wi-Fi and Bluetooth. wireless capabilities of Smartphone and OBD-II devices are given in Fig. 2. [12, 13].

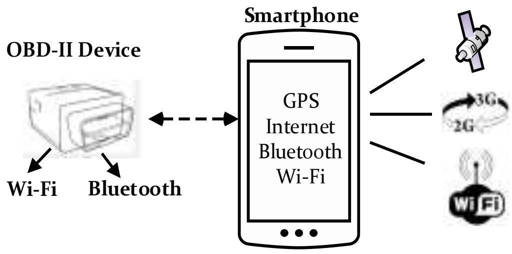

Figure 2. OBD-II Device and Smartphone Communication Structure

At several literature studies the data is transferred to smartphone via OBD-II device [14].

III. APPLICATIONS OF SMARTPHONE TECHNOLOGY

Monitoring of vehicle data in traffic is important for safety reasons for each driver. Productions that enables monitoring data via ECU system while travelling are performed. studies that enable monitoring electronic system in vehicles produced in tecent years with advances in automotive technology. Much more data such as cruise control, the airbag warning lamp, brake warning lamps can be taken. In addition to providing access to ECU system by OBD-II has opened the way for research.

When the future cars are equipped with smart cellular mobile phones and internet, a wide communication network is assumed to be created and in this context our study area has progressed rapidly. Literature review on the subject is given in this part in detail.

Usage areas of the smartphone technology in the Intelligent Transportation Systems can be evaluated in four different categories [14].

- Traffic information for example, location and movements of other vehicles and pedestrians
- Vehicle information for example, vehicle health
- Environmental information for example, road and weather conditions
- Driver behaviour information

The scope of the applications accessing to the OBD-II based vehicle information via the mobile device technology is firstly handled with regards to vehicle information and driver information. However, by means of conveying the ECU data to a system providing inter-vehicle communication, it can be included in traffic information and environmental information systems. In this study literature review has been investigated in 2 parts. To ensure a high-quality product, diagrams and lettering MUST be either computer-drafted or drawn using India ink.

1 Systems allowing the track of ECU data on a Smartphone via OBD-II.

In Fig. 3, examples for the accession of Smartphone technology to the units within the ECU system through OBD-II and the solutions provided thereof are given

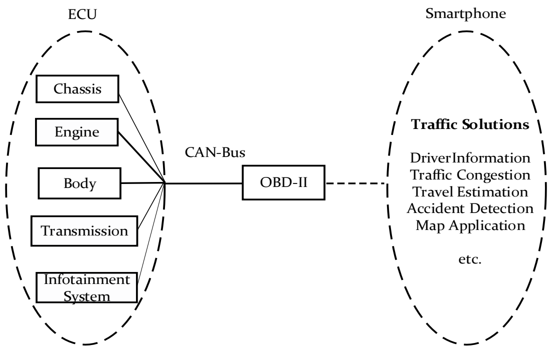

Figure 3. ECU and Smartpohone Communication

Lee et al. [15] Intra-vehicular parameters were used to measure fuel consumption by means of the OBD-II via the ECU. Mathematical modeling of estimated fuel consumption from CAN-Bus was measured through RPM and TPS (Throttle Position Sensor) [15]. In order to achieve similar ends CAN-Bus varies measurements of the vehicle were evaluated while cruising, enabling energy recovery and decreasing fuel consumption through the association of these variables [16].

Atzl et al. [17] developed an Android-based application called Bet4EcoDrive to provide an economic driving style through maintaining a stable RPM rate; it is able to coupled to the OBD-II by means of Bluetooth.

Mitroi and Arama [18] published a study which serves a diagnostic purpose and uses Bluetooth-capable devices. Military intervention vehicles are equipped to run the ELM327 diagnostic device using the Torque program which allows for observable working parameters in situations which require control and conducting.

A Smartphone application developed by Meseguer et al. [19] named DrivingStyles designed to record driving behavior. Classifications of driving styles were compiled through data mining and artificial nerve network technology, which are embedded into the architecture of DrivingStyles. Furthermore, in addition to driver behavior, vehicle parameters such as cruising speed, acceleration and RPM are assessed to characterize the road types negotiated by the moving vehicle. By tracking the ECU data by Smartphone, Preeti and Pande [20] developed a practical and economical method to address unsafe driving. The warning system feature assesses the drivers and increases driving performance.

A mobile diagnostic system which can detect engine malfunction via ECU has also developed. The protocol design allows for the Smartphone to interact with the ECU through a message interfact. Smartphones are able to request and receive the desired variables by communicating with the ECU [21]. This system is able to continuously sent and received up to 31 information variable updates on engine status.Detecting malfunction early is important to prevent the risk of accidents. A similar technological development performs the task of acquiring the driver error data obtained by the OBD-II and relays it to an iPhone by Wi-Fi connection for analysis by the designated application [13].

Magana et al. [22] developed an eco-driving system that can assess classical eco-driving suggestions such as cruising stability in higher gears and smoother deceleration. In order to model the environment around the vehicle multi-network modalities like Bluetooth, Wi-Fi combined with cameras and GPS-capable Android devices are often used. Such systems, which can be used independent of the vehicle models, have been shown to improve fuel efficiency and increase safety.

Baek and Jang [23] developed an application which integrates the OBD-II connection to an external network. The driver is informed of the relevant variants to the OBD-II via the ECU in real-time. They implemented integrating an OBD-II connector that uses Bluetooth, Wi-Fi, and WCDMA modules.

2 The ECU data get via Smartphone and transfer via Internet

Traffic Management System Centers continuously creates solution such as road data, vehicle data, weather data. Smartphone applications can be easily integrated into a system set up in to traffic. It is also widely used in communications infrastructure. In Fig. 4, an example of communication traffic over GSM base station is given. Internet access and GPS functionality in smartphone is used to provide solutions for traffic applications.

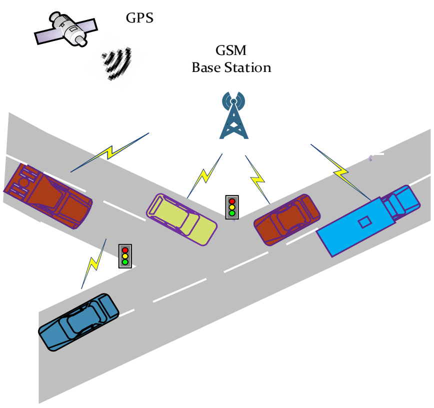

Figure 4. Smartphone communication in vehicles

Tahat et al. [12], a low cost mobile device based system was developed by Lee, allows the driver to monitor the data obtained from the vehicle in order to convey any malfunctions to the manufacturer. The data acquired from the ECU is relayed to an internet-capable Android device from the OBD-II via Bluetooth. Furthermore, data acquired from the vehicle is uploaded be means of a server using a cellular network connection. By determining and predicting vehicle malfunction, the vitally important electro mechanic parameters from the vehicle are communicated to the manufacturer. In a similar development Gabala and Gamec [13] used a program which enables real-time, usable data transfer to mobile devices via OBD-II by means of Bluetooth.Communication with the diagnostic device through the exchange of the ELM327 processor and KAA OBD-II interface has also been developed. Owing to its wide use and ease of programming, Android-based applications have been preferred. Moreover, ELM327 diagnostic devices are the most preferred out of the OBD-II diagnostic devices. Yang et al. [24] developed a CAN-Bus monitoring system which uses Android phones coupled with the OBD-II based ELM327 diagnostic devices. A real-time client and server prototype was developed with Java in order to be tested with collected data.

Zaldivar et al. [25] further developed an Android-based application which displays vehicle and road traffic accident information. In order to sense traffic accidents the estimated G force exerted on the passengers is calculated by the deployment of airbags. The system conveys the address location to emergency services via SMS or e-mail within three seconds of detecting the accident. A separate Android-based application was developed to ensure traffic safety, navigation, and enable remote control capability by displaying virtual graphical information on a mobile panel [26].

Vehicle variables such as engine revolution rate, temperature, oxygen sensor, and fuel status recorded with OBU via CAN-Bus can be loaded onto the VDS by means of WiMAX or 3.5 G. The use of the system is predicated to curtail unnecessary fuel consumption due to vehicle glitches, and decrease air pollution while enhancing driver safety. In a related study the errors related to the model, year, and type of the vehicle has been classified. The error results and repair procedures were able to be reported to the driver. A specific application enables fleet management and vehicle maintenance while having high accuracy for situations requiring tracking [28].

Ruta et al. [29] has commissioned a OBD-II linked cellular information-based system driving assistance. The information is run through a web-based basic variable fusion algorithm which chelates events related to safety whilst interpreting and presents the results. The results have revealed that imparting logic-based and accurate critical warning facilitate the identification of potential risk factors in a timely manner. A programmable and expandable OBD-II device named CANOPNR has been developed in a server-based study. This device reads vehicle parameters stored on the ECU and is able to detect and relay vehicle traction information. The information gained from the status of the road and vehicle is sent to the central cellular server and together with the GPS data which allows visual data to be acquired. A separately developed system is designed to read ABS information and be configured by the driver [30].

Briante et al. [31] established an application called ItsPhone to improve the collection and distribution of data run on a Smartphone-based integrated system. The sensors in the vicinity of the vehicle offer a unique tool by increasing user participation through sensors around the vehicle.

Al-taee et al. [32] developed a smart locator and remote diagnostic data monitoring system called On-Board Smart Box (OBSD). Speeding limit in designated areas can be programmed and are sampled at various control points by reading the OBD-II device in the vehicle; this can provide information about any time the vehicle has exceeded the speeding limit and has been approved to be used by traffic control. The driver is warned in the event that a vehicle exceeds the speeding limit a designated sound and text prompting.

IV. CONCLUSION

In the literature review, it is observed in the systems allowing to track the ECU data on a Smartphone through the OBD-II that the studies on the fuel consumption, determination of driver behaviors, driver information, and determination engine failures were confirmed with the test results. The vehicle information collected thanks to the internet access of the Smartphone technology was shared and assessed for different purposes. The data stored in the server were tracked by the traffic management and inspection centers so that solutions were provided. Furthermore, studies on informing the emergency centers in case of accidents were also performed. During such applications, smartphones with different operating systems were preferred. Hence, it was ensured that all Smartphone users could make use of applications. In many applications, it was observed that the GPS feature of the Smartphone was actively used. The vehicle data collected thanks to the method stated in the articles is expected to provide a solution for the great problem of congestion in metropolis.

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