An In-Vehicle Infotainment Platform for Integrating Heterogeneous Networks Interconnection

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***Abstract*—In order to effectively manage the information exchange between telematics equipment and various terminal equipment in a vehicle. This paper proposes a platform, which uses an in-vehicle infotainment (IVI) system as a heterogeneous networks interconnection gateway. The proposed platform integrates the power line communication (PLC), the visible light communication (VLC), the CAN Bus, and the other related heterogeneous networks. Hence, the platform can be used as a heterogeneous networks coordinator, which is a key role of the intelligent transportation system applications. As a result, with the proposed platform, a flexible network can be organized to achieve vehicle-to-vehicle (V2V) communication, and therefore to provide traffic safety related application services.**

I. INTRODUCTION

With the rapid development of Internet of things (IoT) technique, the automotive industry has also been driven to promote the highly related issue, namely Internet of vehicles (IoV) for many innovative applications. Following such development trend, in-vehicle infotainment (IVI) systems have become an innovative in-vehicle computer system application. Nowadays, the IVI systems differ from the traditional functionalities of listening to radio or video entertainment, but also drive different innovative services and applications being included. Following this trend, the major automotive factories continue to expand the services scope of IVI systems in order to improve the driving quality and experience of drivers and passengers.

The scope of services is from satellite navigation to driving safety, automatic driving, driving diagnosis, *etc*. As a result, more and more terminal devices are required for integration in a vehicle due to the increasingly complicated functions. In other words, it is needed to have a mechanism to effectively manage the information exchange between the telematics equipment (such as an IVI system) and different terminal equipment in a vehicle.

To face such situation, Son *et al.* [1] proposed and discussed cross-platform interactive applications between an IVI system and smart devices. Their work use Bluetooth or USB interface to build an interconnection between IVI system and smart devices based on the GENIVI standard for providing service applications on these smart devices.

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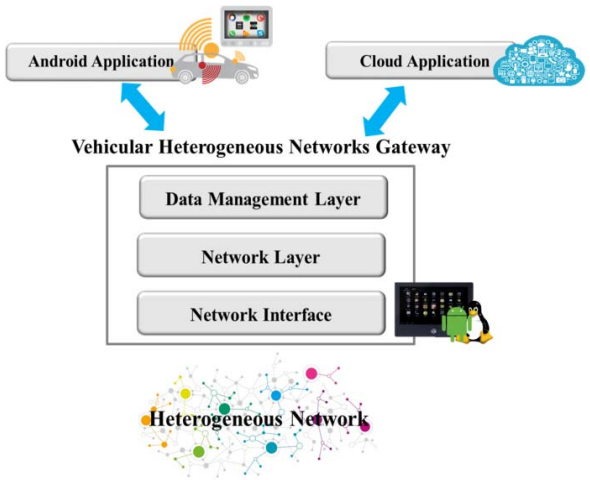

Fig. 1. The proposed IVI platform (vehicular heterogeneous networks gateway) for managing heterogeneous networks information exchange.

However, the driver must have a smart device for getting related web-based services. Considering the driving safety, operating equipment of vehicle is very dangerous while in driving. In other words, it can easily lead to driving distraction.

To face such problem, in this paper we propose a platform, which uses an in-vehicle infotainment (IVI) system as a heterogeneous networks interconnection gateway. The advantage of our proposed platform is that it can provide many heterogeneous networks integration application services without additional equipment (such as a mobile device). Moreover, the proposed platform can collect the messages of many kinds of vehicle terminal equipment to a cloud-based management platform [2], and then these messages could be merged analysis for observing the differences and relevance of these messages. Furthermore, this merged analysis can also develop the differentiated value-added intelligence services.

II. THE PROPOSED INTEGRATED HETEROGENEOUS NETWORKS IN-VEHICLE INFOTAINMENT (IVI) PLATFORM

As shown in Fig. 1, this paper proposes an IVI platform, which is used as a vehicular heterogeneous networks gateway to build an IVI heterogeneous networks information management framework based on the combination of Linux and Android system. Hence, the heterogeneous network communication protocols can be conversed by the proposed platform to achieve the purpose of information exchange among these heterogeneous network communication protocols.

It can effectively make the proposed platform as a gateway that expands to support multiple communication interfaces, and provides driving safety diagnosis applications services.

Figure 2 shows the system architecture of the proposed IVI platform. Heterogeneous networks interconnection can be constructed through the platform, which includes in-vehicle networks (such as power line communication network and CAN bus), vehicle-to-vehicle network (such as visible light communication network), and 3G/4G/Wi-Fi networks.

The prototype of the proposed IVI platform is shown in Fig. 3. Here, we use the standard SAR J1962 OBD-II female connector to connect OBD-II 16-pin diagnostic connector bridge for simulating the electrical signal of the electronic control unit (ECU) on the real vehicle according the ISO 5765-4 CAN OBD-II standard simulator. The vehicle information will be transmitted to the proposed IVI system via OBD-II bridge protocol [7], [8] that integrates our proposed heterogeneous network communications, including power line communication (PLC) [5] for in-vehicle communication, visible light communication (VLC) [6] for vehicle-to-vehicle (V2V) communication, and Wi-Fi/LTE for vehicle-to-infrastructure (V2I) communications [2].

The related vehicle information will be displayed on the screen of the proposed IVI system. At the same time, it can also share the information of the vehicle to the cloud-based remote information management platform for diagnosis services. Therefore, we can determine that the value of the vehicle information is abnormal for contrast with normal eigenvalues. For example, the standard oxygen value of the engine is abnormal and the driving speed fluctuation is too large, will be determined as abnormal status.

In addition, the heterogeneous networks interconnection of the proposed platform can be applied to road safety. For example, VLC can transmit partial vehicle information (such as license plate number, vehicle speed, engine revolution per minute, right/left turn signal, brake, *etc.*) for constructing vehicle-to-vehicle (V2V) dissemination. Such information are very useful to driving safety between front and rear vehicles. Given other example, the front road condition or current vehicle conditions can be actively informed by vehicle-to-infrastructure (V2I) communications and provide immediate and efficient processing procedure by online customer service staff. Such driving safety functionalities could be achieved by the proposed platform.

III. Conclusion

In this paper, we have proposed an IVI platform, as a heterogeneous networks interconnection gateway, which successfully integrated many heterogeneous networks to build interconnection, including IV communications (such as PLC, V2V communications (such as VLC), OBD-II/CAN bus) and vehicle-to-infrastructure (V2I) communications (such Wi-Fi and LTE). As a result, with the proposed platform, a flexible network can be organized to achieve vehicle-to-vehicle (V2V) communication, and therefore to provide traffic safety related application services.

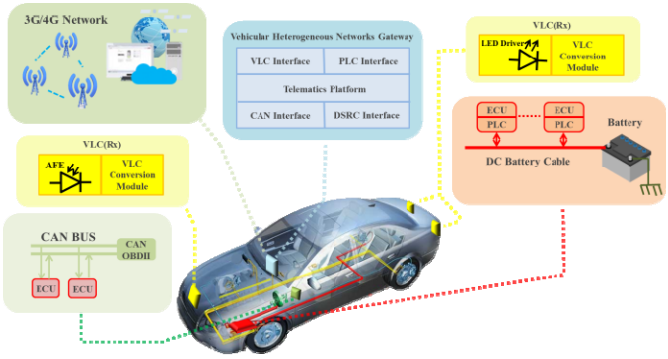

Fig. 2. System architecture of the proposed IVI platform for integrating heterogeneous networks interconnection.

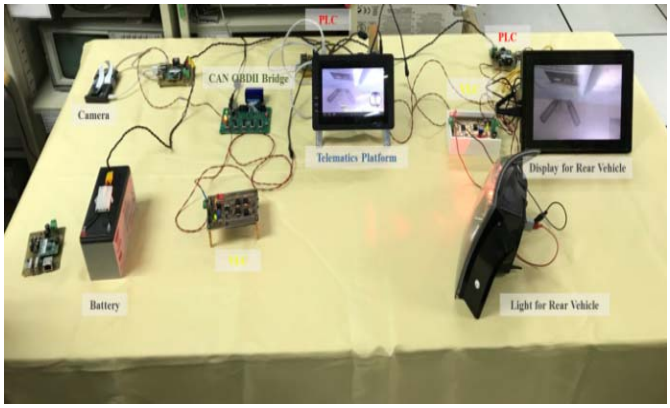

Fig. 3. The prototype of the proposed IVI platform.

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