International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 12 (2017) pp. 3157-3161

Design and Implementation of Android-based MobileSecond Platform Architecture & its Smart Care Service

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Abstract

While the conventional vehicle's Head-Units played very basic roles related to vehicles such as the control of HVAC (Heating Ventilation and Air Conditioning) and the radio reception, they have evolved to serve as an interface between the car and the driver with the advent of the concept of Connected Car and the development of ICT technology. IVI(In Vehicle Infotainment) device, which is Connected Car's Head-Unit, provides various functions such as AV, navigation, information related to vehicle's parts (ex; air pressure, oil gauge) and payment as well as Head-Unit's unique functions. MobileSecond Platform architecture is designed to provide more powerful and diverse convergence services for vehicles and drivers by applying technologies of Connected Car and ICT Convergence in various ways. MobileSecond platform is implemented by applying Android 4.4 to Freescale's i.MX6 HW platform for IVI. In addition, an emotional reasoning framework is developed to provide Smart Care service based on the driver's emotion through MobileSecond platform. Examples of the service implementation that can solve one of the main factors of traffic accidents such as drowsiness are shown in this paper.

Keyword: MobileSecond, ICT Car, Connected Car

INTRODUCTION

ICT(Information and Communication Technology) convergence technology is increasingly being added to automobiles, transforming automobiles into an IT-intensive new platform, not just a transportation. MobileSecond platform linked to ICT Car, which is combined with ICT convergence technology, is an integrated platform to provide various services related to vehicle, operation and driver by connecting the vehicle and mobile devices. It also enables new variety of services such as smart driving service, smart care/self-maintenance, mood & entertainment service, etc.

With MobileSecond platform based on Nexcom's VTC 1010 and Tizen IVI, service applications in the field of vehicle control and smart driving are developed. Because the HW platform and the SW platform used in IVI devices are various, however, it is necessary to upgrade the MobileSecond platform to apply the MobileSecond architecture to more various IVI devices and to develop more various service models.

The MobileSecond platform for Android support makes it possible to use the Android applications, and even in vehicles equipped with IVI, providing more various services than the Tizen IVI-based MobileSecond platform. In particular, even if an IVI device that does not support Android Auto is used, the driver's Android device can be used in IVI via MirrorLink.

Freescale's iMX 6dl and iMX6q Evaluation Board are used to implement the Android-based MobileSecond platform, and Android 4.4 is ported to them.

In this paper, Android Native Library and Crosswalk-based Web-App Interface are implemented to call both Android native application and web application of IVI devices, which are basically required for the Android-based MobileSecond platform. So the vehicle can be controlled in the same manner as in the conventional methods. Examples of Smart Care service implementation based on driver's emotion are introduced as a new service model in this paper.

ECU, VSG, and IVI Inter-connection

Data generated by the main components of the vehicle and the sensors are collected and controlled via ECUs (Electronic Control Unit), and a number of ECUs are composed for each part of the vehicle to cause interaction among ECUs. For example, braking, chassis, steering, and powertrain ECUs manage their own sensors and actuators individually. In addition, several domains are composed to group and manage multiple ECUs, and there is AUTOSAR for the SW standardization for managing such complex ECUs. It is necessary to develop ECU application based on AUTOSAR in order to collect sensor data of each part constituting a car via ECU and to control ECU. Since this method is a manufacturer-level implementation method, however, the VSG is additionally developed to interact with ECUs and to provide an interface between the car and the driver using IVI as a medium. Therefore, the connection structure among ECU, VSG, and IVI applied to the MobileSecond platform is shown in Figure 1.

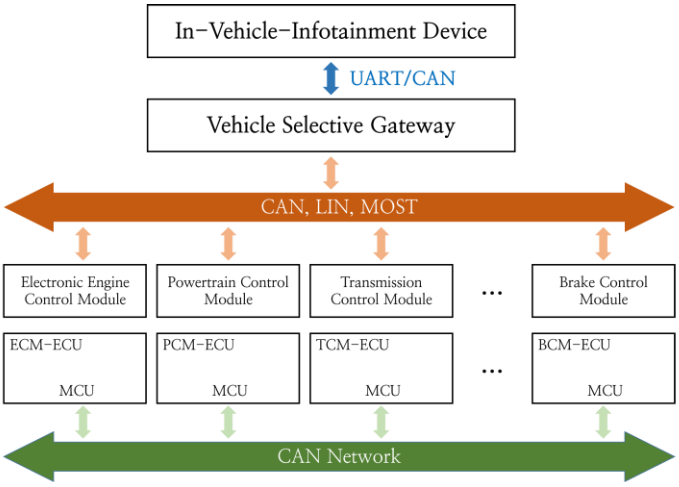

Figure 1. ECU, VSG, and IVI Inter-connection

The VSG APIs are implemented to provide the internal information of the vehicle to the IVI and to receive the control commands through the IVI, as follows.

Table 1. VSG APIs

API Function	Description
getStartVehicleStatus( )	Starting status of the vehicle
getDriverDoorOpen( ) getAssistDoorOpen( )	driver/passenger locked/ open
getFuelLevel( )	Fuel quantity status
getEngineRPM( )	Engine RPM information
getTotalDistance( )	Total mileage information
getDriveSpeed( )	Speed of the vehicle
getAccCount( )	No. of rapid acceleration
getRedCount( )	No. of rapid deceleration
getPBreak( )	Parking gear status
getAirbagStatus( )	Airbag deployment status
getCheckEngine( )	Engine abnormal status
getVehicleID( )	Plate number information
getSideBrakeStatus( )	Parking brake status

Like Figure 2, the VSG and IVI communicate with each other via the API defined above, and the vehicle can be controlled outside by being linked to clouds.

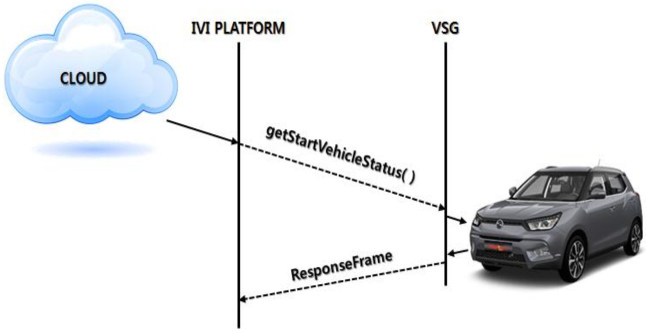

Figure 2. VSG-to-IVI Communication

MobileSecond Platform SW Architecture for Android

By extending and improving the concept of Connect Car, MobileSecond defines the types of services that can be provided to drivers during the actual driving and details the necessary technical elements to realize them specifically.

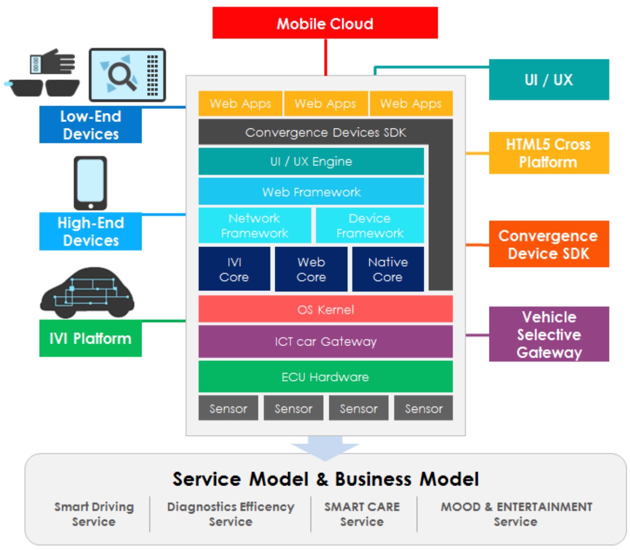

Figure 3. MobileSecond Platform Overall Architecture

Figure 3 shows the SW Architecture of MobileSecond Platform. The ECU, which manages the sensors and actuators related to various functions inside the vehicle, is connected to the VSG, which is the ICT Car Gateway, via CAN, and the VSG is connected to the IVI to serve as an interface between the vehicle and the driver. The IVI core, web core, and native core components are composed to perform Head-Unit's original functions through IVI, and Convergence Devices SDK is provided to enable the development of Web-app and Native App. It provides the vehicle status information for the driver, responds to the driver's requests, and can interwork with other external services by linking to clouds.

The basic services linked to MobileSecond Platform are Smart Driving Service, Diagnostics Efficiency, Smart Care Service and Mood & Entertainment Service. These enable the driver to easily cope with various situations that may occur during driving and provide a pleasant driving environment.

In this paper, Freescale's i.MX6dl and i.MX6q are used to develop IVI devices on Android for connection with the VSG. Figure 4 shows the block diagram of i.MX6.

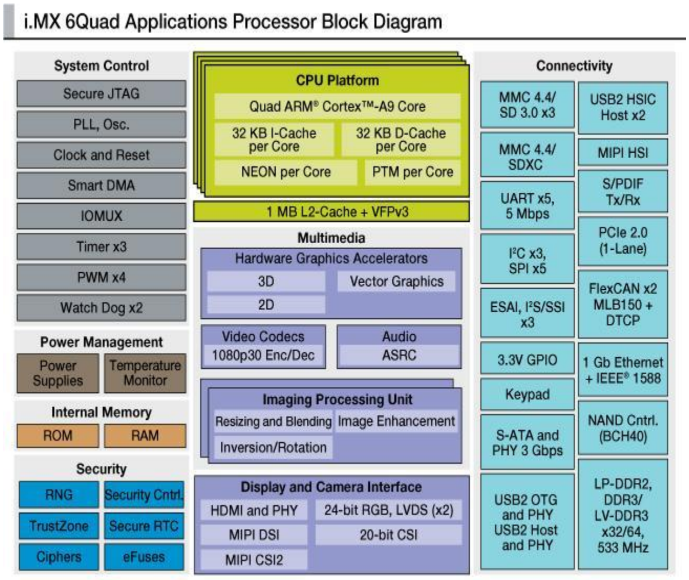

Figure 4. Freescale iMX 6dl/6q Block Diagram

Figure 5 shows the state of Android ported to iMX6q platform.

Figure 5. Android ported on FreeScale i.MX6q

Application Library for Native and Web App

Android 4.4 is ported to the i.MX6-based IVI device. Therefore, it is required to develop APIs that can be used in Android-based Native Application or Web-App in order to control the vehicle by communicating with the VSG. The VSG library needed for developing Android Native Application is developed in the form of the service of Android Framework layer. It is implemented by binding related class libraries as jar format class library to facilitate the development of Android application using the VSG APIs. The binding method of Android Service that provides the VSG APIs is as follows.

```
IFlexcanService flexcanService =
    IFlexcanService.Stub.asInterface(
        ServiceManager.getService("flexcan"));
```

The configuration of the VSG API is shown as in Table 1, and the calling method is specified as the interface of *FlexcanService* components as follows.

```
flexcanService.setStartVehicle();
```

MobileSecond platform provides Web Runtime to support not only the Android Native App but also the Web App as shown in Figure 6.

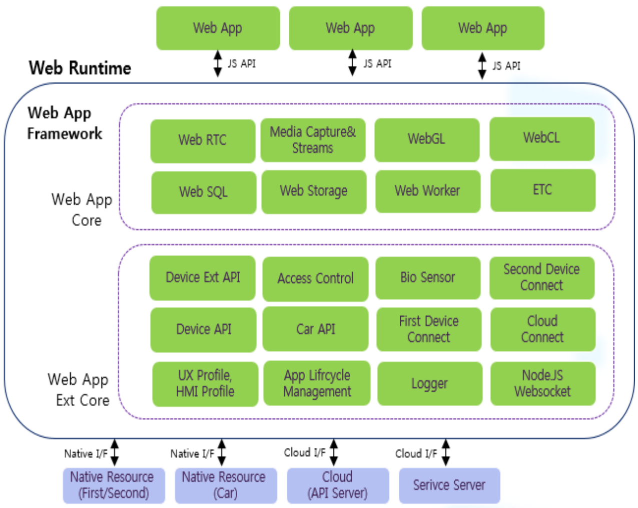

Figure 6. Web Run-Time for MobileSecond Platform

The VSG interface is also developed for the development of Web App based on Web Runtime. Crosswalk is used for this purpose, and the VSG APIs can be called via Java Script. The VSG Web App interface that we provide is implemented as follows.

```
XWalkView.addJavascriptInterface(new
WebAppInterface(), "AndroidVSG");


public class WebAppInterface {
      @org.xwalk.core.JavascriptInterface
      public void setStartVehicle() {
         flexcanService.setStartVehicle();
      }
}
```

Java Script used for Web App implementation can call the VSG APIs as follows.

```
AndroidVSG.setStartVehicle();
```

Emotion-based Smart Care Service

Although autonomous navigation technology has been developed and Uber has operated pilot services for autonomous taxis in the United States[10], a driver should be accompanied to cope with various unexpected situations that may occur during the actual driving. Until now, vehicles have usually been controlled by the driver. Autonomous driving and Connected Car technologies are gradually being introduced; they help the driver to prevent an accident by providing the lane departure information or the sight to be secured by adding a light like LED to the side mirror.

It is common that drowsy driving due to the long driving time, the fatigue of the driver, and the environmental factors, etc. may cause an accident[11]. Physiological signal sensors built in the steering wheel are developed, reasoning the emotion of the driver by collecting basic physiological signals such as driver's PPG, GSR, and SKT during driving. The emotional reasoning method based on physiological signals is based on the results of the existing research[12][13]. The emotional reasoning results can be expressed as a state of a driver's arousal, relaxation, neutrality, comfort, or discomfort, and it is possible to provide services to induce a state of relaxation into a state of arousal or induce a state of discomfort into a state of comfort/ neutrality according to the results. They could also be used to prevent drowsy driving, one of the most common reason of traffic accidents.

The emotional reasoning device built in the steering wheel is shown in Figure 7, and it is implemented in the form attached to the handle or the armrest to collect physiological signals from the driver's finger or wrist.

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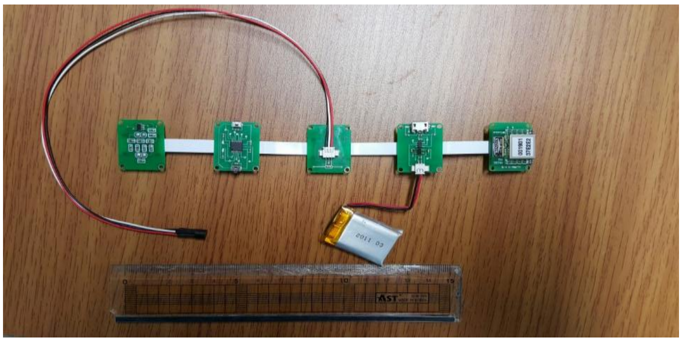

Figure 7. Emotion Sensing Device

Based on these physiological signals, the emotional state of the driver can be deduced as one of three kinds of Normal, Stress, and Sleepy. The application or media can be executed through IVI to relieve the driver's stress or to get out of the sleepy status. Figure 8 shows the emotional reasoning framework needed to provide Smart Care Service based on emotional reasoning in MobileSecond Platform

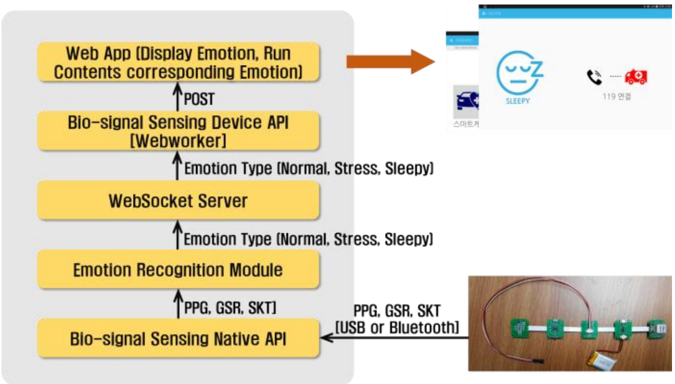

Figure 8. Emotion Recognition & Reasoning Framework

CONCLUSION

MobileSecond platform is an architecture for further expanding the Connected Car. It provides drivers with various services such as Smart Driving, Smart Care, Diagnostics Efficiency and Mood & Entertainment service as well as various information on the vehicle. In this paper, MobileSecond platform is developed by adopting Android as the operating system of IVI, using even the existing Android App in the IVI device in the same way. Two types of Nativie type and Web App type are developed to use the VSG API for the collection and the control of the vehicle's data via the ECU even in Android App.

For Smart care service, which is one of service model types of MobileSecond platform, devices to obtain the driver 's physiological signals and the structure of the emotional reasoning engine framework to operate them are introduced. Driver's physiological signals like PGR, GSR, and SKT are collected and the process of linking to IVI applications is implemented based on emotions reasoned by the emotional reasoning engine framework. The Android-based MobileSecond platform we designed and developed is expected to serve as a reference for the development of services based on Connected Car and ICT car.

ACKNOWLEDGMENT

This work was supported by the Industrial Strategic Technology Development Program(10073159, Developing mirroring expression based interactive robot technique by non-contact sensing and recognizing human intrinsic parameter for emotion healing through heart-body feedback) funded By the Ministry of Trade, industry & Energy(MI, Korea)

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