A Study on a Design of V2N Beacon Service on Road Traffic Accidents Prevention

Minyoung Kim, Jongwook Jang

Abstract: ***In this paper, when the driver operates, it tries to design a beacon service that informs the driver in advance of obstacle information on the road. In this system, we will use the Beacon function of BLE (Bluetooth Low Energy) to implement V2N (Vehicle-to-Nomadic Devices) communication even without existing wireless communication infrastructure. This system is configured as a "transmitter" device for informing obstacles in which a road occupant is installed in advance and a "receiver" device is for collecting information on obstacles and informing the driver.***

Index Terms: V2N (Vehicle-to-Nomadic Devices), BLE (Bluetooth Low Energy), Beacon, Smartphone, Roadway obstacle

I. INTRODUCTION

If the driver can know in advance the information on various situations of the road being operated, the driver has a lower probability of getting in a traffic accident. For example, if the driver knows beforehand the unintended obstacles on the road (e.g. Repair work on the road, parked vehicles on the road, etc.) and the area where the frequent traffic accident occurrence (e.g. a sharp bend in the road, Region of emergence of wildlife, etc.), the driver can be careful the situation when driving his own car(Figures 1).

When the driver of a vehicle drives, it is the purpose of the service in this paper to collect obstacle an information on the road and an information on the dangerous section of the road and confirm in advance. For example, if a driver who stopped a vehicle suddenly on the road notifies this fact to other road users, the driver who confirmed the fact can drive safely the vehicle as avoid the obstacle. Also, if the driver knows an information of the dangerous section of the road before entering it, the vehicle can safely drive.

Therefore, in this thesis, it includes which we studied contents necessary for the development of the V2N (Vehicle-to-Nomadic Devices) beacon service. This paper's service is composed of "the information transmitter" notifying the road condition information (The obstacle information on the road or the dangerous section of the road, etc.) and "the receiver" is which receives this information. In order to implement the V2N communication of the two devices (The information transmitter and the receiver), the data communication of each device is executed by using the Beacon function of BLE (Bluetooth Low Energy). Because each device must communicate with each other even in an environment without existing wireless communication infrastructure.

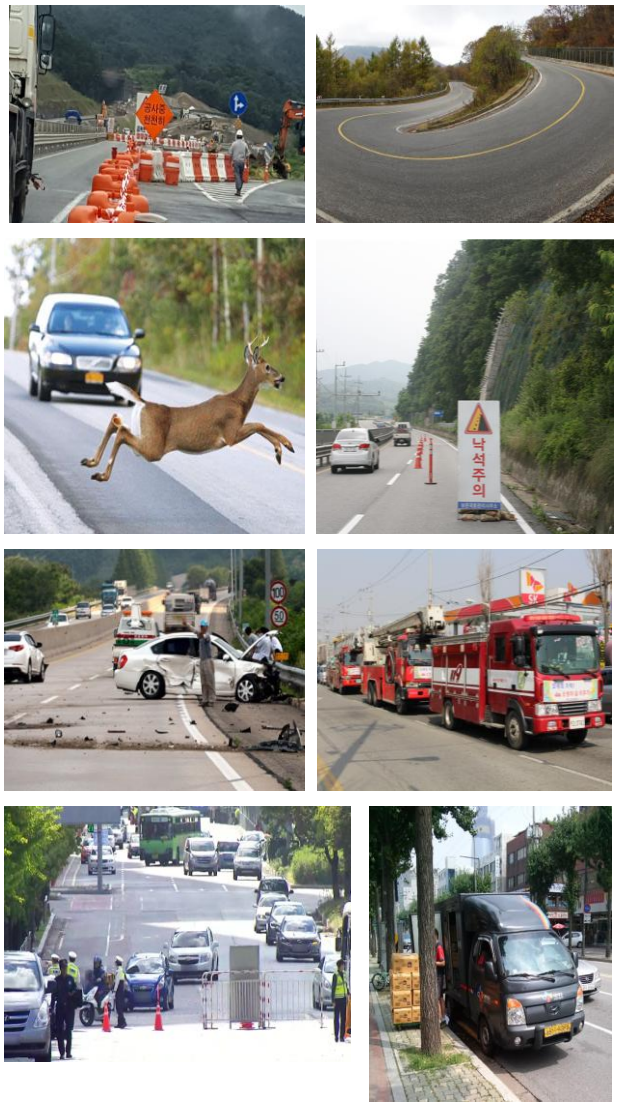

Fig. 1 The example of obstacles on the road

The Configuration of Service

In this paper, The V2N beacon service (hereafter referred to as 'the service') is composed of 'the information transmitter' notifying the road condition information (the obstacle information on the road or the dangerous section of the road, etc.) and "the receiver" is which receives this information. The components of this system must communicate on the move. So, these devices have nomadic propensity.

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The network topology of BLE used in the service adopted broadcasting type which is a non-connection method. This is suitable for the system because the purpose of the transmitter is to transmit its own data to the peripheral receiver regardless of whether the transmitter is connected to multiple receivers or not. In this service to which this topology is applied, 'the transmitter' is a broadcaster that regularly performs the role of transmitting information data in the form of packets and 'the receiver' is an observer that checks repetitively a predetermined frequency band [1].

One of the purposes of the present service is to enable the transmitter and receiver to communicate at any time and in any situation. The reason for choosing the BLE network topology of this service is to build a V2N network on the road without using the existing wireless network infrastructure. If a country has a good wireless network infrastructure, the client server model service is applicable on it. Because the client server model service needs continuous connect stably between a server and clients. However, other countries have difficulty using the service model. We want that all countries used the service. So, we adopted the topology in the service.

III. RESULTS AND DISCUSSIONS

A. The Transmitter - Results

The transmitter of this paper (hereafter referred to as 'the transmitter') uses BLE to transmit information data to the nearby receivers at regular intervals. The transmitter can be classified into various types according to the installation location as shown in “Table 1”.

Table 1 The Classification of The Transmitters by Function

Type	Role
Vehicle	When the driver stops the vehicle, it transmits information data to the road user in the vicinity
Nomadic	When a user occupying a road other, the user transmits the indicating obstruction information data at the surrounding road user.
Stationary mounted	It is installed on the outskirts of the road and transmits the information data necessary for used road to the user who uses the road. (e.g. Accident-prone areas, rapid curve area, etc.)

The transmitter uses the advertising control function of the Generic Access Profile (GAP) of the host layer of the BLE to transmit information data indicating whether the transmitter exists (Figure 2). The receiver performs to transmit the advertising packet according to the present period using the post control function [2].

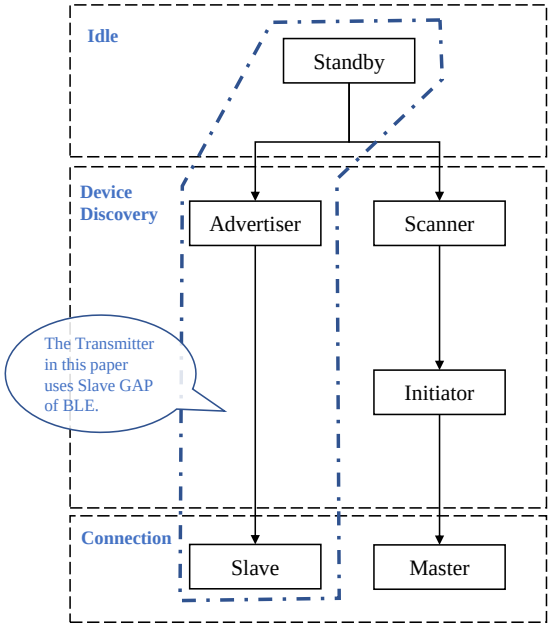

Fig. 2 GAP State Diagram of BLE [3]

The central processing unit of the transmitter is suitable for a 32-bit MCU (Micro Controller Unit). Because the transmitter is transmitted the simple messages to nearby receivers. It is appropriate to develop the transmitter based on a SoC(system-on-a-chip) with a BLE stack. “Figure.3” shows the hardware design block diagram of the transmitter based on the BLE stack SoC [4].

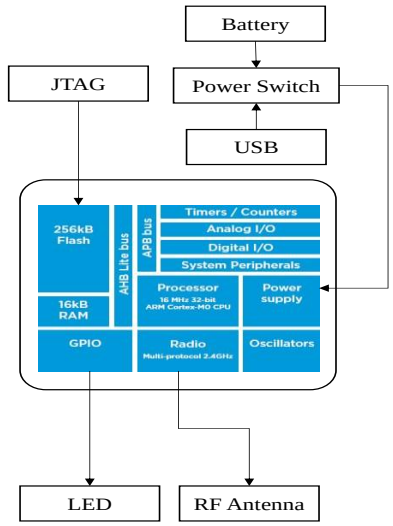

Fig. 3 The Hardware Design Block Diagram of The Transmitter

The transmitter uses a high output dipole antenna so that the receiver spreads horizontally. So, it is not difficult to receive data [5]. When used the system in Korea, the transmitter must transmit the information data to receivers ranging from a minimum of 100m to a maximum of 500m. It is based on the Korean Road Traffic Law [6].

The transmitter is mainly used outdoors. So, it makes an external case to meet IP (International Protection) standards. The appropriate IP rating of the case is IP54[7]. Because the transmitter needs to send the information data to the neighbouring receivers while protecting the raining and foreign objects (Table 2).

Table 2 The Chart for IP 54 Level [8]

Inspection items	Level	Inspection contents
Solid	5	Dust Protected. Limited ingress of dust permitted, but will not interfere with operation of the equipment
		
Liquid	4	Protection against water splashing from all directions. Limited ingress permitted.
		

B. The Receiver- Results

The receiver of this paper (hereafter referred to as 'the receiver') receives the transmitted information data by the nearby transmitter and informs the driver of the received data. The receivers are available in the form of mobile applications that can run on existing smartphones (Android or iOS) or navigation which built-in BLE stack module. This can improve the accessibility of the system to the driver by utilizing the existing equipment used in the vehicle.

The application includes a function of searching for the same frequency band as the receiver using the BLE module in the system background and informing the user of various types of data when receiving the transmission data. The notification method is different for each information data. Upon receipt of the information data from the transmitter, the position of the transmitter is calculated based on the RSSI (Received Signal Strength Indicator). The equation for obtaining the distance by RSSI is as in (1) [9].

$$d = 10^{[P_0 - F_m - P_r - 10\times n\times log_{10}(f) + 30\times n - 32.44) \div 10\times n]} \quad (1)$$

It is the final role of the receiver to output the guidance information such as “Obstacle detected before 50m!” (Figure 4). Nowadays, when driving a vehicle, it should be reflected in running a notification application in the system background, considering running a navigation application on a smartphone.

Fig. 4 Notification Message on Android OS

CONCLUSION

In this paper, we propose a vehicle beacon system based on BLE to prevent traffic accidents caused by abrupt obstacles while the driver using the road. In this paper, we explained the purpose of using BLE for V2N communication, the components that make up this system. And the function implementation goal is for V2N communication without the wireless communication infrastructure in the vehicle beacon system.

In order to implement the vehicle beacon system of this paper, there are several aspects to be considered in addition to the contents mentioned in this paper. A redesign is needed to be based on the road law of the country in which this system is used. And the system needs a solution to solve the congestion in the broadcasting communication. Finally, we must study the way that how to activate this system in the society of applied country.

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