Development of Smart Device and Mobile Application for a Bike

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Abstract: - Free bike program is spread all over the world and bikes are considered an important transportation method in urban area. Expensive bikes are also used in leisure. However, bikes are often lost and broken by a thief. To solve these problem, we developed a low-priced smart device attachable to a bike. We also developed a smart phone application for the device. The device has a differential global position system, a vibration sensor, and a communication module. If parked bike is touched by someone, the device detects a vibration and sends an alarm message to predefined phone number. When the user rides a bike, the device gets the GPS signal and sends the position to a smart phone application. The application shows current position on the map and also displays travel history. We also proposed a communication method for multiple bikes travel. It is cost effective and requires lower battery power. The smart device and application provides anti-theft function, tracking the travel path and current position on the map.

Key-Words: - Bike, App, Master, Slave, Internet of Things, WCDMA/LTE, Bluetooth

1 Introduction

Free bike program is approximately 60 years old and spread all over the world [1-4] Bicycles have several advantages over the other modes of public transportation for short short-distance urban trips because they reach underserved destinations, require less infrastructure, are relatively inexpensive to purchase and maintain, generally do not add to vehicular congestion, do not create pollution in their operation, and provide the user with the added benefit of exercise [5]. Public bike-sharing program, however, faces some problems - bike theft, vandalism, bike parking. To solve the problem, information technology is applied such as smart phone application, or RFID technology.

The Internet of Things (IoT) is also used in the free bicycle program to give more convenient functions to users. The term ‘‘Internet-of-Things’’ is used as an umbrella keyword for covering various aspects related to the extension of the Internet and the Web into the physical realm, by means of the widespread deployment of spatially distributed devices with embedded identification, sensing and/or actuation capabilities [6]. It gathers various sensor data such as GPS signal, motion data, and sends them to users using the Internet.

In this paper, we developed a smart device to facilitate bike usage and to reduce bike theft. A smart phone application is also developed to show useful tracking data and receive alarms from the device.

This paper is composed as follows. Chapter 2 shows a smart device that attached in a bike. Chapter 3 describes a smart phone application connected with the device. Chapter 4 describes an algorithm for detecting unintended motion and sending an alarm message. Finally, Chapter 5 concludes the paper.

2 Smart Device for a Bike

A smart device, that is attached in a bike, gathers GPS signal and various sensor data. It also sends the gathered data and an alarm to a smart phone application. The block diagram of the device is shown in Fig. 1. It shows main parts of the system and is composed of GPS module, WCDMA module, alarm module, sensor module and battery part.

We use differential global positioning system (DGPS) as positioning technology, because the accuracy of DGPS device is about 5 meters. The DGPS, that is based on satellite, is available in all weather conditions. It can be used to facilitate vehicle guidance with a digital map and can be added at a lower cost [7]. The technology is used various areas especially in vehicle positioning [8-10]. The WCDMA module is used to send an alarm to predefined phone number. The alarm module makes big sound if unintended motion is detected when a bike is parked. The sensor module contains

an acceleration and a gyro sensor. It detects a motion and invokes an alarm.

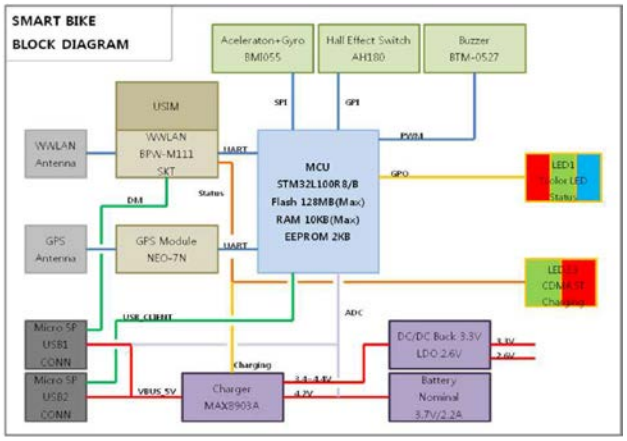

Fig. 1. Block diagram of smart device

We have designed a PCB for smart device based on block diagram. The board should be very small and the battery capacity should be enough for several days' operation. Fig. 2 is a prototype of the system that is packed in a fixture shown in Fig. 3. The fixture is attached in the body frame of a bike.

Fig. 2. Prototype of smart device

Fig. 3. Fixture of smart device

3 Smart Phone Application

We have developed a smart phone application for tracking travel path, showing current position on the map, and setting alarm signal. The application is developed on the android mobile platform and java programming language.

It receives positioning signals from the smart device and shows current position on the map shown in Fig. 4. The travel path is also recorded in the database and can be loaded from the history list shown in Fig. 5. First it shows all travel information with time and location. When a list item is selected, it shows the travel path on the map.

Fig. 4. Showing current position

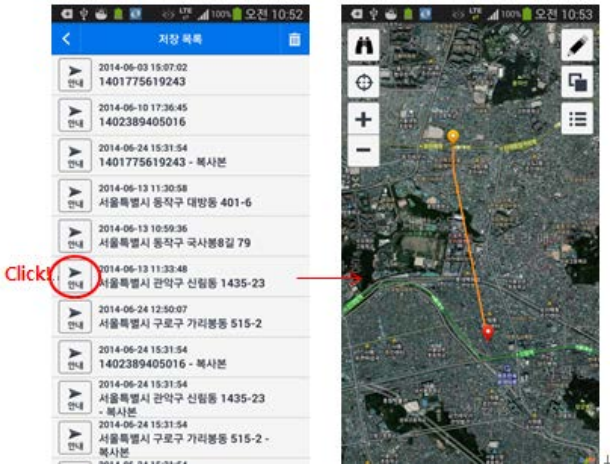

Fig. 5. Tracking travel path

Third function of the app is a kind of anti-theft. It monitors the bike status and sends some messages to users. As shown in Fig. 6, an alarm message is sent to the predefined user phone by the smart device, if

the parked bike detects some motions such as shaking, or a vibration of the bike. The user determines next action. If the bike is located in near area, he/she will go to the area and find out what is happened to the bike. If nothing is happened, the user will turn off the alarm. If the bike is parked in far area, the user will track the bike position on the map shown in the application.

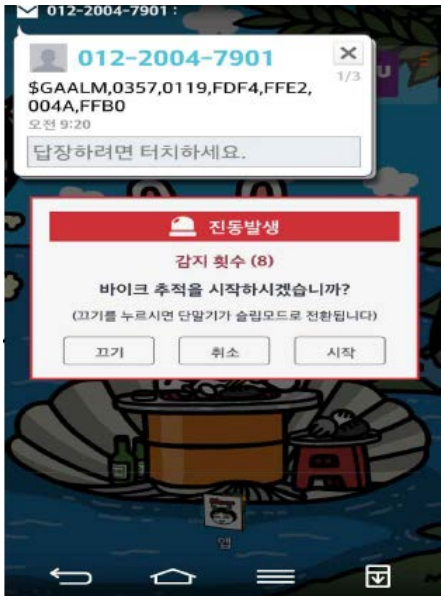

Fig. 4. Receiving alarm message

4 Communication of smart devices

In this chapter, we will describe a method for a communication of smart devices. It is cost effective and lower power consuming. The method is used in multiple bikes communication.

WCDMA or LTE communication requires higher power consumption than local area communication such as bluetooth. Moreover, some cost is involved in data communications. When multiple bikes move together and take a rest together, new approach is proposed to prevent bike-theft. Bikes in a group is classified in a master and slaves shown in Fig. 7. The relationship of a master and slaves is one-to-many. A slave is conneted with a master using a bluetooth and turns off 3G/4G communication to reduce the power consumption. When a slave detects some motions, it sends the location and the identifier to the master. The master is responsible for sending an alarm message that contains an identifier and location of the slave.

When the mobile application receives an alarm message, it finds a proper phone number associated with the slave, and forward the alarm message to the user.

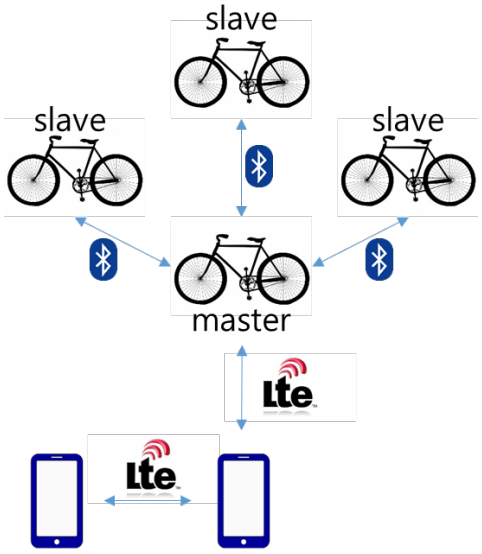

Fig. 7. Communication of smart devices

5 Conclusion

We have developed a smart device based on Internet of Things, that has sensors and communication modules. It is attached in a bike and sends useful information to biker's smart phone application. The application receives the sensor data and displays the travel path and current position. The smart device also sends an alarm to the user, if the parked bike detects some vibrations. We have proposed an algorithm for a communication of bikes and users. The algorithm reduces inside power consumption and data communication cost.

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