저전력 블루투스를 사용한 사용자 성향 분석 시스템

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Customer Preference Analysis System using Bluetooth Low Energy

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요 약

In this paper, we present a customer preference analysis system using the Bluetooth Low Energy technology. Compared to Classic Bluetooth, Bluetooth Low Energy provides considerably reduced power consumption, and cost, as well as some unique characteristics while maintaining a similar communication range. The customer preference analysis system collects nearby Bluetooth Low Energy devices using an Android mobile device via Bluetooth Low Energy. In addition, the system is capable of suggesting, and advertising products that are related to these Bluetooth Low Energy devices based on the name of their manufacturer. This feature aims to attract potential customers to purchase these products.

1. Introduction

Nowadays, Bluetooth is a well-known technology that provides a wireless link for local connectivity as a cable replacement. Bluetooth Low Energy (BLE) is a completely new technology. With rapid development of technology, manufacturers often launch new high-quality products to attract potential customers. We have implemented a customer preference analysis system aims to meet the needs of these companies. This system is divided into two modules. The first BLE module collects information of all the nearby BLE devices in the vicinity, and obtains the name of the companies of these devices. The second Display module receives information from the BLE module, and providers suggestions to customers about the different types of products manufactured by these companies.

The rest of this paper is organized as follows. Section 2 providers a short overview of related works and major features of BLE along with the system. Section 3 describes the implementation of our system. Section 4 discusses an experiment we conducted along with its results. Section 5 providers a short conclusion. We conclude the article with acknowledgements.

2. Related work

Many approaches have been proposed to estimate and calculate the distance between mobile devices at fixed stations and Bluetooth devices based on the Received Signal Strength Indicator (RSSI) using Bluetooth classic [1]. Although it can handle a large amount of data, its battery life is short and, thus, is more expensive. This paper introduces BLE as a new technique that is capable of sending a suitable amount of data at low cost, consuming far less energy. In addition, BLE can contain the measured RSSIs of these BLE devices [2-5].

3. Customer preference analysis system

The customer preference analysis system is illustrated in Figure 1. In our approach, we expect to uniquely identify Bluetooth enabled devices in order to track them. BLE devices share their MAC addresses that allow us to identify the devices uniquely in every broadcast. In order to obtain the RSSI, either the RSSI is read for the connected devices, or a Bluetooth discovery is performed to check the RSSI for any BLE devices nearby. A Bluetooth discovery is a broadcast to all stations within a range asking them to respond back. For each device that responds back, Android will fire off an ACTION_FOUND message and we can obtain the RSSI. We receive the MAC address of the BLE device along with the RSSI and this gives us the quality of the transmission for each device. RSSI values usually vary between -40 dBm (decibel-milliwatt), for the nearest positions, to -90 dBm, for the farthest positions. In the tests performed, devices at a distance of 10 meters reported an average of -50 dBm, while the ones situated at a distance of 50 meters reported an average of -75 dBm.

Therefore, we can determine the closest BLE devices using the discovery scan. In addition, we have to restart the discovery scan every second to determine any new device that may become visible. To transmit information related to all the closest Bluetooth devices to the Display module, as mentioned earlier, every second. The compute performance difference between PC and Android devices. Therefore, owing to low power consumption and low cost, we chose BLE technology for data transmission.

4. Experiments

Initially, in order to transmit data from the BLE module to the Display module, both these modules must establish a

Bluetooth connection. The BLE module has to search for an active device that is implementing the Display module if they are not yet paired. Subsequently, a passkey must be exchanged between the two modules to complete the pairing operation.

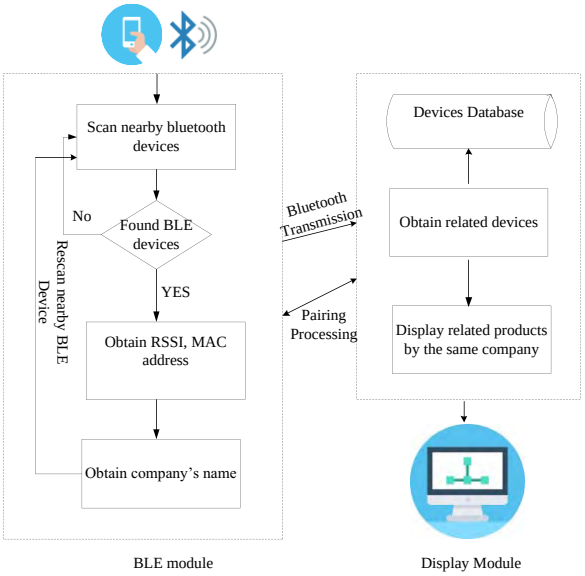

Fig. 1. Structure of the system

Once the Bluetooth pairing has been established, the MAC address in the Display module will be used to get the BluetoothDevice object. Based on this BluetoothDevice object and the registering Universally Unique Identifier (UUID), the BLE module can obtain a BluetoothSocket object. Finally, the connection between will be established by using the "connect" method of the BluetoothSocket class. Scanning for nearby Bluetooth devices and exchanging of data every second utilize a large amount of RAM and may result in memory leaks. To avoid memory leaks, we devised a mechanism that releases memory whenever the process of data exchange occurs. As expected from our previous analysis, exchanging and receiving data smoothing in the Display module.

In the Display module of this system, information received will be used to obtain the information for products by the same manufacturers by querying the database. Complete product information will be obtained to provide suggestions to potential customers through the devices database. The latest products by these manufacturers will be displayed as shown in Figure 2.

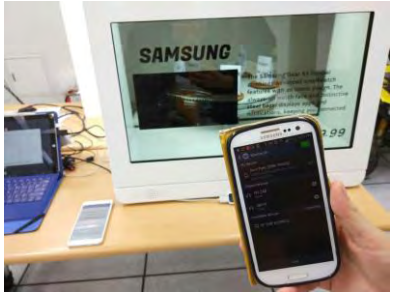

Fig. 2. Suggestions and advertisements of a few of the products related to nearby BLE devices

5. Conclusion

The customer preference analysis system, proposed in this paper, can be viewed as a new method to not only influence customers to use the products, but also to advertise other high-quality products and the latest technologies. We have focused on designing the system using BLE and the aim is to gain efficient connections requiring low-energy in order to reduce its power consumption. The experiment shows that our method achieves good results and transmits data over shorter distances. Although detecting nearby Bluetooth devices achieves good results, occasionally, it results in unstable RSSI values. As a consequence, we have to estimate the range for nearby BLE devices, as previously mentioned. A few higher versions of Bluetooth in Android devices are known to cause instability. Therefore, as future work, besides enhancing the system by adding more features, we will investigate and overcome this Bluetooth issue caused by a few high-versions of Android

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