Automatic Generation of BLE Beacon Applications

Using Service Specifications

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Abstract

Since Apple first introduced iBeacon technology in 2013, BLE beacons have been used to develop new services and generating new markets. Today, BLE beacons are playing important roles in a lot of IoT(Internet of Things) services and location-based mobile services. But building those services need considerable amount of money, preventing more people from getting benefit through the new technology. In this paper, we present a method of building basic services using BLE beacons in an automated way. The method introduces two editors: one for specification of BLE beacon formats, and the other for specification of the related services. Through the editors, services such as the alarm notification condition on some field of beacon data, the filters for beacon data can be specified easily. The method analyzes the resulting values from both specifications, extracts the appropriate parameters, and inserts the parameters into the template application which

is built in advance with HTML5 technology as the skeletal application. Finally, the complete application is generated as the target service in association with the BSmart platform.

Keywords: BLE beacon application, Automatic generation, BLE beacon, beacon format editor, beacon service specification

1 Introduction

The Bluetooth Low Energy (BLE) technology enables a device to communicate in one of two states: connected and advertising modes. A BLE beacon usually means a device broadcasting its small content formatted in a specific way through the advertising mode of the Bluetooth 4.0 protocol. Since Apple first introduced iBeacon technology in 2013, the BLE beacon technology has been one of the core technologies associated with the era of Internet of Things(IoT). Utilizing BLE beacons in various application domains, people can obtain more precise positioning data of objects and the trajectories of objects both indoors and outdoors. Accordingly, many services [1] [2] [7] [8] have been developed using BLE beacons with various data formats [3] [4].

Although BLE beacons are gaining more popularity, the costs for building services using them are still considerably high. So, it would be desirable to develop easy methods for building such services. In this paper, as the extension of our previous work [5], we present a method of generating basic services based on BLE beacons in an automatic way, inspired by the fact that most of such services are location-based, monitoring the positions of the interested objects and retrieving the trajectories of those objects. The method introduces the editor for specifying BLE beacon formats to support any kinds of beacon formats. BLE beacons can be produced by a variety of companies with different formats. In addition, the system provides another editor for specifying the mobile service related to a beacon format specification, which designates the alarm notification condition on some field of beacon data, the filters for beacon data and etc. The method also provides the template application which embodies the basic functionality of the location-based services in a skeletal way using HTML5 technology. Obtaining the needed values from both specifications and applying them into the template application, the method automatically generates the complete HTML5 application as the target service in association with the Web services provided by BSmart platform [6].

2 Background

2.1 BLE Beacon
As a short-range wireless communication device, a Bluetooth beacon can deliver information to one-way only using low power in the advertising mode. The BLE beacon technology has solved not only the difficulty of providing location

services indoors but also the shortcomings of the NFC technology to transmit information within the maximum of only 10cm away. Beacon released by Apple can be used for high-precision position detection systems based on BLE beacons, and currently being widely adopted in a variety of O2O(Online-to-Offline, Offline-to-Online) businesses. The format of BLE beacon packet has non-fixed area which can be delivered as application-specific data. IBeacon [3] has modifiable area by 20 bytes and AltBeacon [4] has 26 bytes.

2.2 Mobile Services Based on BLE Beacons

WingK [1] is one of O2O services using BLE beacons released from SK Telecom and Kyobo Book Centre. After installing the beacons with iBeacon data format in particular locations within the store, WingK provides the user-specific information to the lock screens of the smartphones of users through the location service based on the beacons. Other services using BLE beacons generally utilize the position information from the beacon function. BC Card and Lotte Card also provide useful information about tourist attractions and events to the tourists through the deployed mobile applications based on the position information from beacons.

3 Theoretical Background

3.1 Beacon Format Specification

To generate applications with various types of BLE beacons, there needs a tool for specifying packet formats to be broadcasted by the beacons. So, the method provides a beacon format editor that enables users to specify the packet format of the beacons and the meta-information on each field of the format, which can be helpful and useful for building the associated application with meaningful user interface. In general, any format is possible according to the policy of the beacon production company. But, the widely used beacon types such as iBeacon, Eddystone and AltBeacon have their own non-modifiable area, which are supported by the beacon format editor. A sample editing screen of the beacon format editor is shown in figure 1.
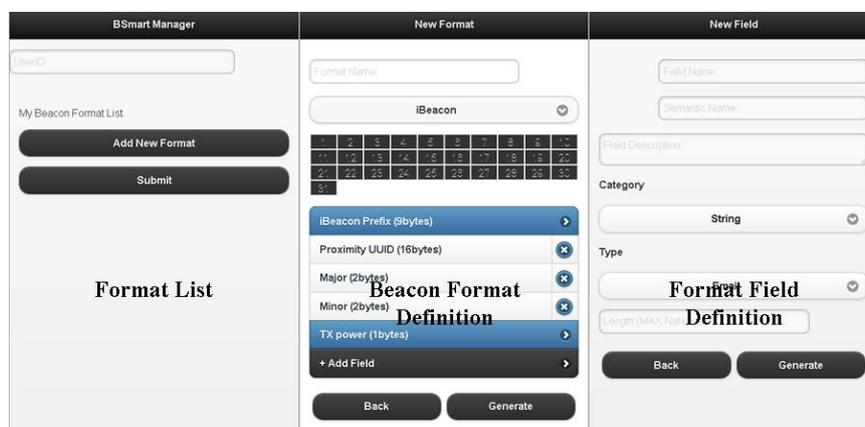

Fig 1. Sample Screens of the Beacon Format Editor

Using the format editor, users can create the specification file on the format and the related information of the target beacon. The specification file is uploaded to the BSmart server. The edited beacon format is stored in the specification file as JSON(JavaScript Object Notation) syntax. Figure 2 and Table 1 shows the content of a sample format specification file and the meanings of JSON structure used for specification.

```
{
"userId" : "testuser",
"format" : [
                {
                        "formatId" : "0",
                        "formatName" : "User Format",
                        "fields" : [
                                {
                                        "fieldId" : "1",
                                        "fieldName" : "User ID",
                                        "semanticName" : "User ID",
                                        "description" : "user's beacon ID.",
                                        "category" : "String",
                                        "type" : "Text",
                                        "length" : "16"
                                },
                                { ... }
```

Fig 2. Sample specification of a beacon format

Table. 1. Explanation of JSON specification on beacon format

Name	Objective
userId	ID for identifying the BSmart user
formatId & formatName	ID and name for identifying the beacon format
fieldId & fieldName	ID and name for identifying each field in beacon format
semanticName & description	Meaningful name and description of the field to be used in the associated application
Fields::type & style	Data type and syntax style of a field
length	The number of bits occupied by the field

3.2 Beacon Service Specification

To specify services required for mobile applications using BLE beacons, the method provides another editor called beacon service specification editor. Such mobile services usually require current positions of users (or beacons) and the trajectories of users (or beacons) for a certain period of time. In addition, these services often require alarm notification in case that the location of a user (or beacon) turns into an area that is out of some predefined value. Through the service specification editor, service developers can specify what kinds of services they intend to provide. The outcome of the specification work with the editor is described as JSON syntax and is also uploaded to the BSmart server. Figure 3 shows sample screens of the beacon service specification editor during the specification process.
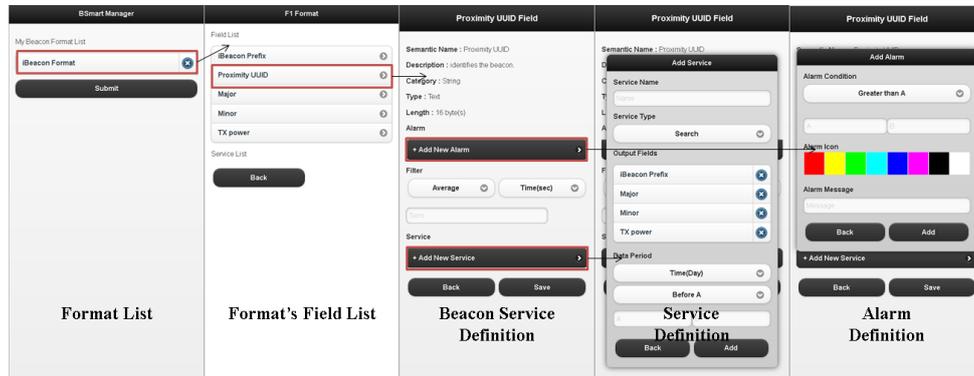
Fig 3. Screens of beacon service editor

Using the editor, users can specify alarm notification on a certain field of beacon data. The condition for generating alarm notification can be specified in three ways. The first one is when the field value from a beacon turns greater than the predefined value, while the second one is when the field value from the beacon turns lower than the predefined value. The third one is when the field value from the beacon turns between some predefined values. In addition to the basic monitoring and retrieving services, filtering the beacon values is supported through filters for average value or cumulative value and so on. Figure 4 and Table 2 show a sample service specification file and the meanings of JSON structure used for specification.

Fig 4. Sample specification of a beacon service

Table. 2. Explanation of JSON specification on beacon service

Name	Objective
Alarm::type & value	Set the range of the alarm value on beacon field value
Icon & message	Set notification color and message to user
FilterType	Filtering method(Average, Min, Max…)
periodType & term	Set period for filtering.(How often to receive the field value)
Service::type	Type of service provided(search or monitoring)
outputfield	Set the result of executing service

3.3 Template Application for Generating Service Application

The template application is a skeletal service application as the basis for providing the basic functions for usual beacon-based services. To support cross-platform services, the template application is built with the HTML5 and jQuery Mobile technology. The template application is used as the template for generating the required service application. The parameters for each real service associated with BLE beacons are extracted by analyzing the two JSON files containing the beacon format specification and the beacon service specification. The developed system inserts these parameters into the appropriate positions in the template application, generating the complete service application. Figure 5 shows the screens of the template application.
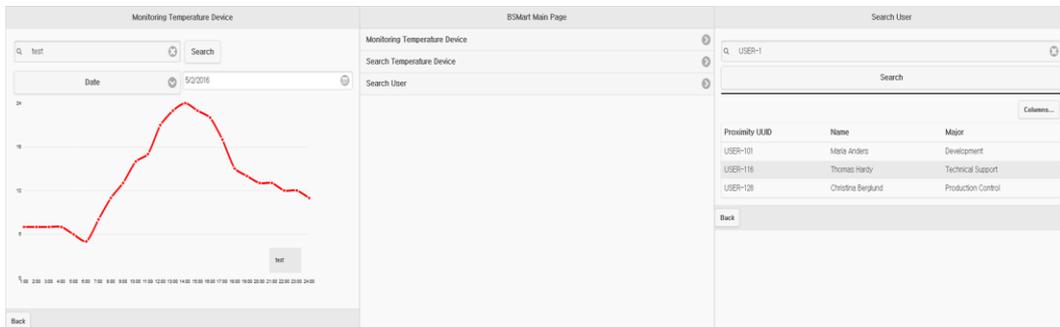

Fig 5. Screens of template application

To integrate the parameters extracted from the specifications of a beacon format and the related service into the template application, we use the matching method. The matching method sets the parameters to the corresponding predefined field list and completes the beacon service application by integrating each value of the field lists to the proper area of the template application. Figure 6 shows an example of this process.
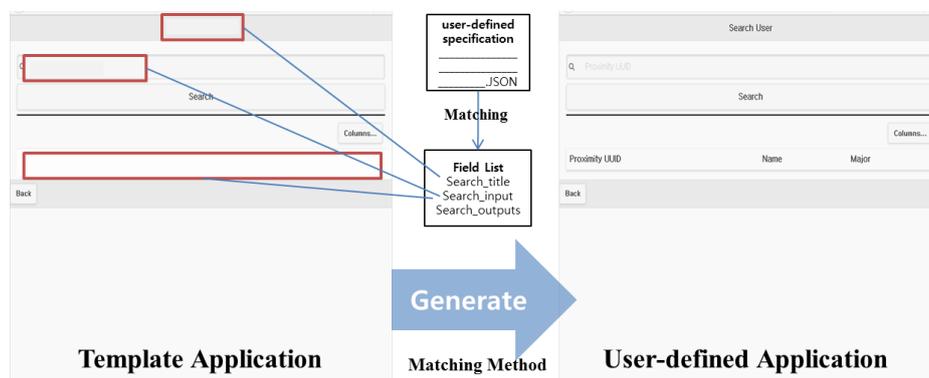
Fig 6. Process of generating beacon service application using matching method

4 Conclusion

In this paper, we introduced a method for building mobile applications based on BLE beacons in an automatic way. Basically, the method presents the template application implemented with the HTML5 technology, which supports the basic functions required for most of beacon-related services. Into the template application, the application parameters appropriate for a specific real beacon-based service are incorporated by the developed method. These parameters are obtained from the specifications of the data format of the related beacons and the services required in association with the fields of the data format. For this, the method uses two editors: one for the specification of BLE beacon formats, and the other for the specification of the related services. The method analyzes two JSON specification files resulted from the two editors, extracting the appropriate parameters. Finally, the method generates the complete implementation of the target application. We believe that the presented method would make the development of mobile services based on BLE beacons significantly easy and cheap, which means more people could get benefits from the BLE beacon technology under a lot of circumstances.

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