Development of Smart Tourism app Using Bluetooth Low Energy Beacons

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Abstract: The Jeju special self-governing province deployed BLE Beacons at 21 major tourist attractions and offering them through Beacon SDK for smart tourism app developers. In this paper, we develop a Bluetooth low energy (BLE) beacon app for smart tourism to revitalize the traditional market which is losing competitiveness due to the large-scale shopping mall. We represent the traditional market as a zone type of complex sightseeing spot, a sales area as a sub-zone type, a walkway as a line type, and shops as POIs. The user can view the location and route of the stamp Beacon in the market with the map view service of the app. The app's smart tour guide service also provides a push notification service when you travel into the Beacon radius of your chosen store before traveling. After the trip, the app provides the user to purchase a product from the same store that he or she purchased while traveling.

Index Terms: BLE Beacon, Location-based Service (LBS), Smart Tourism, Tourist Attraction, Android App.

I. INTRODUCTION

Smart tourism is the application of Internet of Things (IoT), communication infra such as WiFi and Bluetooth low energy (BLE) Beacon, cloud computing, big data, and artificial intelligence (AI) [1]-[4]. Smart tourism should provide tour information and tour guidance services before, during, and after the trip. We have been developed the smart tourism app to provide the personalized travel products which can be created based on the tourism big data analytics [5,14-23]. Before the trip, users can select the recommended travel products and create the personalized travel products using sightseeing spots, restaurants, and hotels in the app. The app provides the zone based complex tourist information that is composed of the information of the line type and POIs as well as the sub-zone type tourist attractions. During the trip, the app provides tour guidance service to the user based on the schedule of the personalized travel product interworking with communication infra such as free WiFi and beacons in sightseeing spots. We have constructed pedestrian networks through four iterative steps: on-site data collection, path generation, annotation, and on-site inspection. The constructed pedestrian networks can be used for smart tour guide in the major walking tourist attractions such as Hallasan national park, Oreums, Olle trails, global geoparks, and natural recreation forests in Jeju

. We also constructed pedestrian networks using GPS trajectories and photos in the walking tourist attractions in urban area server-based TTS engine [6]. The audio tour guide system provides tourist information optimized for tourists using tourist context information such as language, age, gender, preferences, and local information such as date, time, location information, and weather.

. The developed pedestrian networks can be used to create KML map data for complex sightseeing spots. The KML map data can be serviced on map views on Google Maps in the smart tourism app. We also developed the location-based multilingual audio tour guide system using the Jeju special self-governing province provides Beacon SDK and Beacon information to develop smart tourism webs and apps using Beacons installed in 21 major places such as Jeju international airport, Jungmun tourism complex, and Dongmun market [7]. The Jeju special self-governing province also has established the tourism big data platform for analyzing not only beacons but also access logs of WiFi APs, big data collected from public and private sectors, and provides Jeju provincial tourism big data analysis information [8]. KT provides the TrIP (Travel Intelligence Platform) of tourism analysis solution to provide tourist information on major tourist attractions and festivals through big data analysis of call data records (CDRs) of mobile communication network and access logs of WiFi APs and beacons in Jeju [9].

Bluetooth Low Energy (BLE) also referred to as Bluetooth Smart [10] is one of the wireless communication technologies for IoT devices and was introduced as part of the Bluetooth 4.0 core specification. Beacons are small, inexpensive and power-efficient radio transmitters based on BLE which repeatedly broadcast radio signals called advertising packets at periodic intervals. The devices equipped with Bluetooth 4.0 such as smartphones, tablets in proximity of the beacon can receive advertising packets and can load contents from the Internet with a mobile App using these advertising packets. BLE Beacons can be used in the areas of proximity marketing, hyperlocal check-in, retargeting Ads, asset tracking, and indoor navigation.

As large-scale marts are opened in the region, the number of visitors to traditional markets is decreasing, and merchandise is shrinking. In order to revitalize the traditional market, local governments are modernizing the building of

the market and improving the surrounding environment. In this paper, we developed a smart tourism app to activate the market by using beacon in Dongmun market, which is a famous traditional market installed in BLE beacons. In this paper, we develop BLE Beacon app to provide smart tourism services to revitalize the traditional market.

II. SMART TOURISM BASED ON BLE BEACON FOR REVITALIZING THE TRADITIONAL MARKET

We have developed a smart tourism app and contents to provide tourists with smart tourism services based on ICT convergence before, during and after the trip. The smart tourism app will develop recommended travel products based on the results of tourism big data analysis. Users can use the smart tour guide service during the trip according to the travel schedule of the selected the recommended travel products from the app. The recommended travel products include zone type, line type, and point type tourist destinations. The zone type of complex sightseeing spot can be composed of sub-zone type, line type tourist attractions, and POIs. The tourism big data analysis uses tourism big data collected from communication infrastructure such as CDR (call data record) data of mobile communication, WiFi and Beacon connection data. Jeju special self-governing province provides free WiFi to major sightseeing spots and buses, and analyzes WiFi access data to provide visitor attractions and route data. Users can use wireless Internet services on buses and sightseeing spots where free WiFi is installed with one-time authentication.

Jeju special self-governing province has installed BLE Bacons at 21 major Jeju tourist destinations including Jeju international airport and Dongmun traditional market as a Beacon pilot project as shown in Fig. 1(a). Beacons are deployed in 50 stores in Dongmun traditional market which is a famous traditional market of Jeju as shown in Fig 1(b). Smart tourism platform [10,14-18] provides private BLE Beacon information through partnerships as well as beacons installed by Jeju special self-governing province. Smart tourism platform collects BLE Beacon access data for use in tourism big data analysis. In this paper, we develop a smart tourism platform based on BLE Beacons to activate the traditional market.

We modeled the Dongmun traditional market as a zone type of complex tourist attraction and created the market tourist information. The market was modeled as a sub-zone for selling fruit, fish, meat, miscellaneous goods, etc., and related tourism information was created. The walkway of the market is created as the line type tourist information and the information of the shops where Beacons are installed is created as POI. The line type tourist information consists of line type data constructed by node and link in geographic information system (GIS) using the GPS log data and two dimensional map. We create KML map data using the line type data and POIs and related storytelling data in the market and provide it as a map view service in the app. In this paper, we added location information of beacons provided by smart tourism platform to KML map data so that the location of beacon installed in the market can be confirmed by the map view service of the app as shown in Fig. 2. The user can check

the sub-zone of the market, line type data, shop location, and beacon location in the app. Before the trip, users can use the app to check the market information, sub-zone information, line type data, and store information where beacons are installed. Users can include the Dongmun market in their personalized travel products and choose the shops they want to visit in the market. During the trip, users can use the smart tour guide service of the app to access the push notification service when they enter the beacon radius of the selected store.
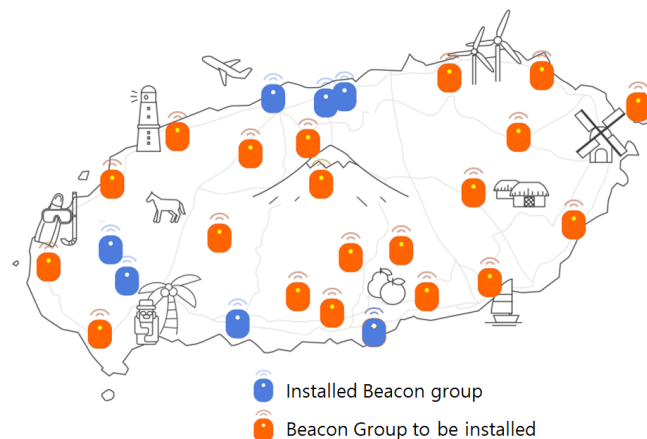
(a) 21 BLE Beacon groups including Dongmun traditional market

(b) 50 BLE Beacon locations in Dongmun traditional market

Figure 1. BLE Beacon location information provided by the smart tourism platform.

Figure 2. KML map data for Dongmun market on Google earth.

The smart tourism platform based on BLE Beacons is configured as shown in Fig. 3. The infrastructure layer consists of BLE Beacons provided by the smart tourism platform [10]. The platform layer manages BLE Beacon information and provides beacon location information, beacon ID, and Beacon status to the user. The BLE Beacon platform also provides user access data and big data analysis data.

The application layer consists of mobile App developed with BLE Beacon SDK and the smart tourism server providing smart tourism service based on BLE Beacons. The smart tourism server provides data for providing the smart tourism service as well as Dongmun market store information. The smart tourism services based on BLE are provided in the procedures as shown in Fig. 4. In the BLE Beacon management phase, the BLE Beacon information such as UUID, Major and Minor deployed in Dongmun market is registered on the BLE Beacon platform [12]. The smart tourism server also registers the Dongmun market store information as shown in Fig. 6. Users can choose stores and save the store information on the smart tourism app where they want to visit before or during their travels. During the trip, the BLE Beacon app with the Beacon SDK acquires BLE beacon ID and notify the user when a user renters the coverage area of the Beacon registered on the Beacon platform. If the Beacon ID is a Dongmun market stamp Beacon ID, the BLE Beacon app automatically stamps it as shown in Fig. 5. If the beacon ID is a pre-registered favorite store's Beacon ID, the BLE Beacon app also provides the store information to the user.
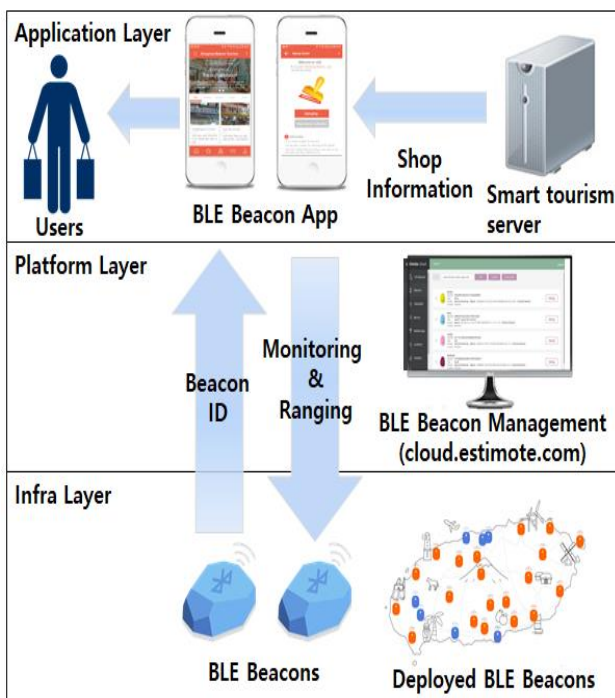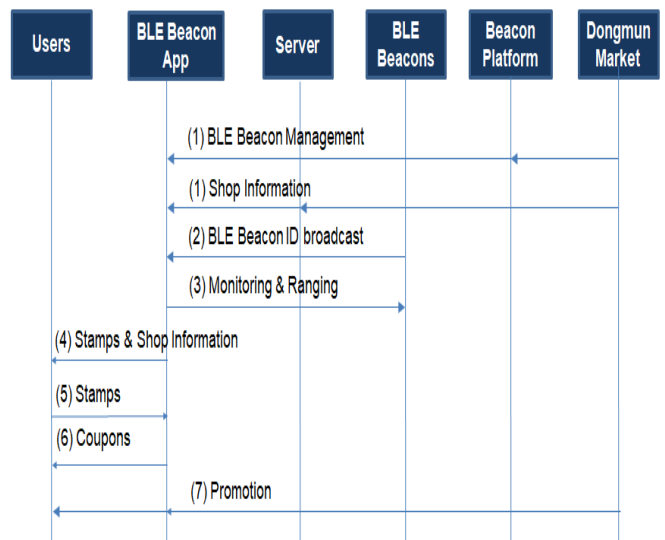

Figure 4. The Procedures for providing smart tourism services based on BLE Beacons.
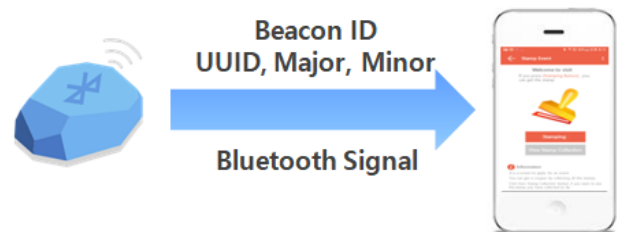
Figure 5. Get UUID Major and Minor from BLE Beacon Device.

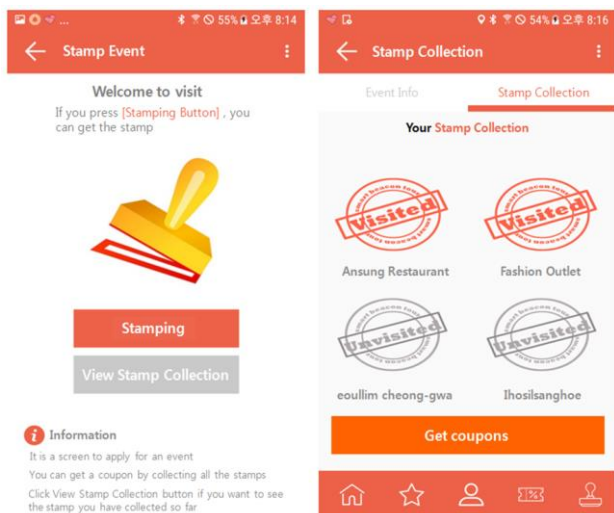Figure 3. The smart tourism platform based on BLE Beacons.
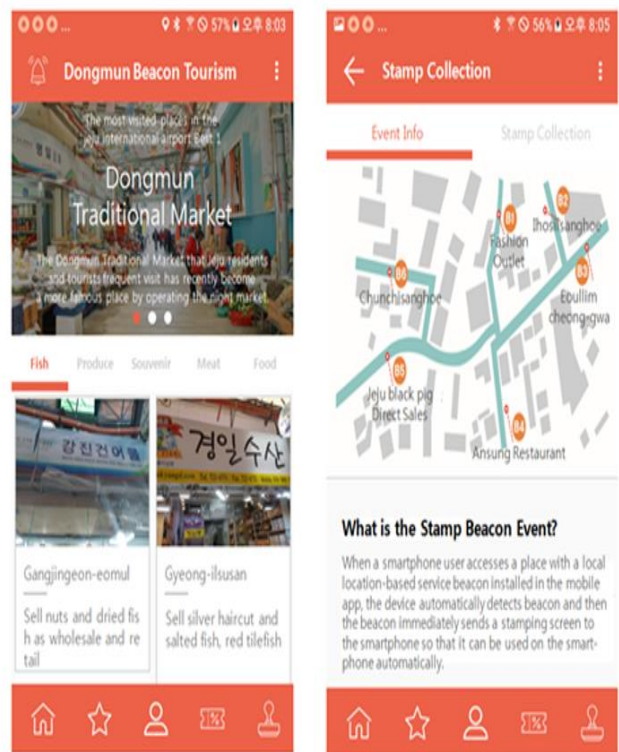
Figure 6. Screens related to the stamp service in the BLE Beacon app.

The app is building related information by managing the stores in the market with POIs as shown in Fig. 6. The app provides the ability to select a store to visit at the market before traveling. The BLE Beacon app provides a Beacon stamp service so that tourists can visit the entire market to activate the traditional market. The user can easily purchase desired items in the market using the sub-zone information of the market. The app shows the location where the beacon is installed through the map view service and automatically stamps when the user arrives in the area.

When the user stamps the entire stamp Beacons installed in the predetermined path and the local gift certificate is provided to the user. Users can purchase goods in the market with local gift certificates. Marketing promotions to promote traditional markets will be implemented after installing additional stamp beacons and developing additional features of the app. After the trip, the app provides users to purchase goods from the stores that they purchased while traveling. The app can provide a reliable way to sell local specialty goods by linking online and offline store of sightseeing spot.

III. CONCLUSIONS AND DISCUSSION

We develop the smart tourism app that users can use before, during, and after the trip for smart tourism. Jeju special self-governing province has installed 1,147 BLE Beacons in 21 major tourist destinations and provides information on location of IDs through the Beacon SDK for smart tourist app developers as a smart tourism platform. In this paper, we develop a BLE Beacon app for the revitalization of traditional market using the Beacon SDK and the information of 50 Beacons deployed in Dongmun traditional market in Jeju. We provide the location and path of stamp beacons in the market with KML map data on the map view service in the smart tourism app. Before the trip, the user can select recommended trips with the traditional market and stores to visit in the market during the trip. The user can use the smart tour guide service based on personalized travel products as a smart tourist app during travel. When the user enters the Beacon coverage area of the selected store before the trip, the

BLE Beacon app provides the store information with the push service. During the trip, users will be able to view the location of the stamp using the app's map view service and receive a local voucher when they stamp all the beacon stamps in the app. After the trip, the app provides a reliable O2O service to sell local specialties of traditional market stores

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