BLE Based Object Locator

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***Abstract*: The task of tracking missing items is often time consuming and tedious. When the boundary of lost item is huge, localization of the item is challenging. Objects of care can be localized and tracked by attaching BLE tags to them. These tags are cheap Bluetooth tags that broadcasts a unique ID. They can be tracked by the application, when a user passes by the lost object. As the tags are tracked in the background of the application, it involves minimum user interactions. The application can then notify the server about the location. The location is displayed to the lost object's owner on a map. As the number of users increase, the ease to track lost devices also increases.**

***Keywords:* BLE, Crowd sourcing, lost object tracking**

I. INTRODUCTION

As human beings, we lose or misplace many of our belongings every day. It could be our mobile phones, keys or wallets. However, searching for them is time consuming. When we lose things outside rather than indoors, the localization task could be more challenging since the search area gets larger.[1] Moreover, when what we lose is our loved ones such as pets and vulnerable individuals like children or elders, the process of finding torments us more due to involvement of emotions. Recently, with the widespread adoption of smart phones, crowd sourcing based solutions have been provided for this challenging task. Harnessing the power of a mass of geographically dispersed user devices with Internet connectivity, an invaluable crowd GPS service is developed towards the goal of localizing lost items. With the release of Bluetooth Low Energy (BLE) that allows low cost near range communication, several vendors have created tiny, battery-powered, BLE tags that can easily be attached to the objects of care. These BLE-enabled (or beacon) tags connect to the users' mobile devices in the vicinity via Bluetooth and send updates to the device to indicate its presence. However, such updates do not reach the device when the distance between them is more than the limited range of BLE communication. [5]With the crowd GPS service, collaboration of multiple user devices is targeted to achieve an enhanced coverage for the localization of lost items. That is, when an item with a tag attached is lost, any nearby user in BLE range could detect it in a transparent way and notify the server and eventually the user who owns it, with the current location information. In the spatial crowd sourcing context, the main focus is the optimal matching of user and tasks, while giving priorities to several different factors (e.g., privacy). The system should be an efficient and user friendly aid for people who have lost items and will help them localize it with the collaboration of users in an active manner.

II. LITERATURE SURVEY

Different methods have been implemented for location tracking using the latest technologies like GPS, NFC etc. Localization of people's belongings through the sensors on mobile devices has recently been studied under different names such as people centric-sensing, participatory sensing and mobile crowd sensing [5]. With the proliferation of smart phones that are equipped with multiple sensors, the need for deploying and maintaining separate dedicated sensors for such kind of service is invalidated. There are myriads of tracking systems. Some are indicators which has the data collected after an item has passed a point (like bar codes). Others are 'real-time' like Global Positioning System (GPS) and depends on how often data is refreshed. There are barcode systems which require a person to scan items and automatic systems for identification of tags (RFID auto-id). Most of the tracking systems are composed of discrete hardware and software systems for different applications. Some of tracking methods are mentioned below:

A. GPS Tracking

A GPS tracking unit is a navigation tool that uses the Global Positioning System (GPS) to track the device's movements and determine its location [2]. The location data can either be stored within the unit or transmitted to an Internet-connected device using the cellular (GPRS or SMS) or satellite modem embedded in the unit. This allows the location to be displayed against a map backdrop in real time using GPS tracking software. This type of tracking software is available for smart phones with GPS capability. A GPS contains a GPS module that receives the GPS signal and calculates the coordinates. For data logger, it contains large memory to store the coordinate of the location. Data pushers additionally contain a GSM/GPRS/CDMA/LTE modem to transmit this information to a central computer either via SMS or GPRS in form of IP data packets. Satellite-based GPS tracking units will operate anywhere using satellite technology.

B. Radio Frequency Identification Tag

A Radio Frequency Identification Tag (RFID tag) is an electronic tag that exchanges data through radio waves. Most RFID tags are made up of two parts. The first is an antenna, which receives radio frequency (RF) waves [3]. The second is an integrated circuit (IC) chip, which is used for data exchange received or sent through the antenna. In RFID technology, the term "tag" also includes labels and cards. These tags operate in either Ultra High Frequency (UHF), High Frequency (HF) or Low Frequency (LF). Thus, tags can also vary in terms of the frequencies on which they operate.

C. Near Field Communication Tag

Near-field communication (NFC) is a communication tag that enable devices (such as a smart phone) to establish connection when bringing it within a small range. NFC devices are similar to credit cards and electronic ticket smart cards and allow mobile payment to replace these systems [4]. NFC is implemented in social networking, for sharing contacts, photos, videos or files. NFC offers a low-speed connection with simple setup that can be used in wireless connections. NFC employs electromagnetic induction between antennas to exchange information.

C. Bluetooth Low Energy

BLE is a form of wireless communication designed for short-range communication. BLE is similar to Wi-Fi in the sense that it allows devices to communicate with each other[6]. However, BLE is meant for situations where battery life is given importance. For example, you want to broadcast campaigns in the close proximity of a newly launched head phone. The amount of data you need to transfer to a visitor's smart phone is extremely small, hence BLE compatible beacons do the job quickly without draining the battery. BLE data transfer is essentially a one-way communication. Bluetooth Low Energy beacon broadcast packets of information at regular intervals. These data packets are detected by app/pre-installed services on nearby smart phones. This BLE communication triggers actions like pushing a message or promoting an app. To save energy and provide higher transfer speed, the entire BLE communication framework consists of 40 frequency channels, separated by 2MHz.

III. EXISTING SYSTEM

A Support System for Finding Lost Objects using Spotlight by Toyohisa Nakada, Hideaki Kanai, Susumu Kunifuji employs an active RFID and ultrasonic positioning to detect position of object.

AmbiSense which is used for Identifying and Locating Objects with Ambient Sensors by Dr. Christian Hoene employs sensors and robot vision to locate objects.

IV. PROPOSED SYSTEM

The system is an android application for smart phone users. Initially, the user should attach BLE tags to his belongings (wallet, bike etc.). Using the application, he can add his BLE devices to the smartphone just like pairing to a Bluetooth device. These BLE devices are listed in the application, each having a corresponding find button. When the find button is clicked, the details of the BLE device is send to the server. The details include MAC id of the device and information to identify the user. The application has a list of lost BLE devices that they keep on searching in the background. The server updates the list of lost devices for every active application, adding the new lost device id into it. Each active application searches for the lost devices using the Bluetooth module of the smart phone. If any smart phone that comes in range of the lost device, it sends its location to the server notifying that the device was found in that location. The server can further notify the lost user about the location. The part where the application searches for lost devices is a background process and the user who finds the location will not have any knowledge about the lost device, which adds to the privacy and security of the object.

V. SYSTEM DESIGN

The system is designed in such a way so as to provide an interface for lost users to locate and track their lost devices as quickly as possible. The system will be suitable as a mobile application because smart phones are the most accessible device to humans.

A. Input Design

The application maintains a list of devices that are paired to it. The list also contains the MAC id of the devices, which needs to be send to the server with the user's lost request as input. This information is vital to initiate the scan process. During a successful scan, the application sends the smart phone's location to the server. If the user is in a tunnel or a subway, there is a chance that the location obtained might be faulty due to wrong estimation. The location information may also be misleading in the case of multi floored building.

B. Module Design

The major modules of the system are listed as follows:

1. **User**

User should pair the BLE devices into the application. Such paired devices are attached to his belongings. The user can click the find button of the corresponding device in the application to know the location of his device. The user is provided with these provisions: log into application, add device, and check location of objects.

2. **Application**

The application identifies each user and device with a corresponding id. When user clicks the find button the required id is send to the server. The application maintains a list of lost devices and scans for those devices in the background. The application is provided with these provisions: to search for lost devices, send information to server and display the location.

3. **Server**

The server obtains all the lost requests with the data containing the unique id of the lost BLE device and the unique id of the user. The server updates the lost device list, adding the new lost device into it. When a smart phone using the application comes in range with any of the lost device, it sends the location to the server. The server notifies the lost user's application with the location and the application can render the location into a map. The server finally deletes the lost device info from the list so as to prevent more smart phones in searching for the same.

C. **Output Design**

The server notifies the lost user about the location by rendering the point in a map and providing the distance and routes to the spot. The location is send to the application as a geolocation object. It has attributes for latitude and longitude. Upon receiving the location the Map API can be used to generate the map.

The dataflow diagram is shown in figure 1:

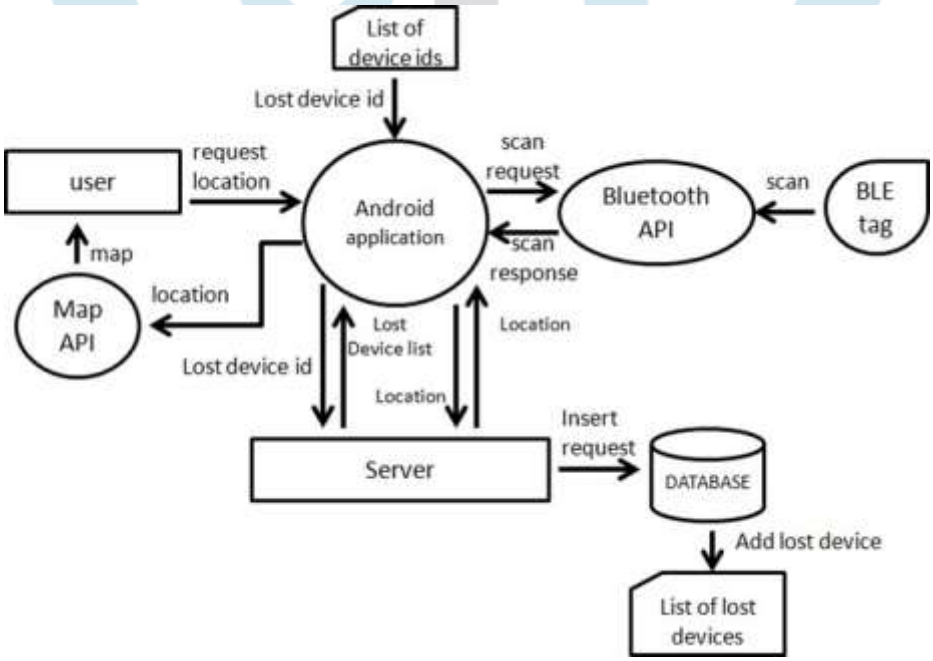


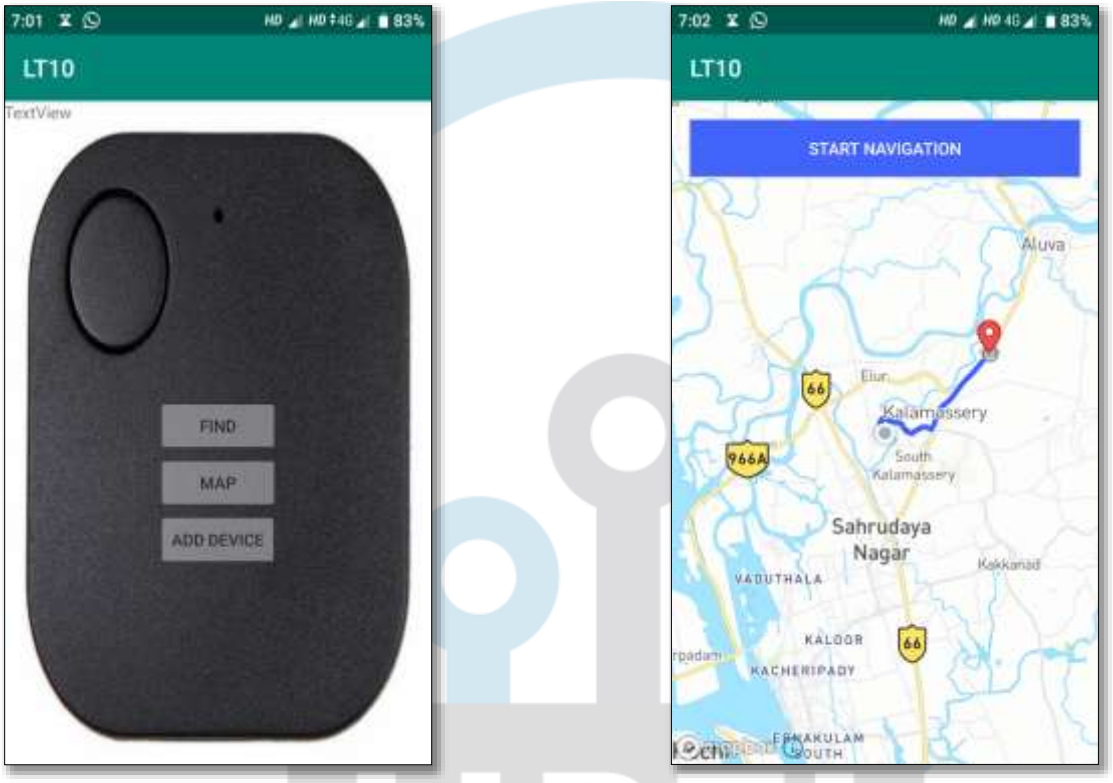
Figure 1: Proposed System Framework

VI. RESULT

In this proposed system, we have tried to easily locate lost objects by attaching BLE beacon tags on to them. The system will be able to find a device's location if a user passes by a lost device and his application was able to get a signal from the tag. The BLE tagging system stands as an energy efficient way to track lost belongings. The scan process can run in background and doesn't need user supervision. Keeping user interaction to the minimum is also necessary. When user interactions are minimum then users' privacy is also valued. The success of the system is entirely based on the number of users with an active application. The location

is shown in a map with the distance from the lost user's location. The output is visible only to the lost user. The map is generated using the Map API. The system has been tested by finding many misplaced objects both in short range and in long range. The system is reliable and requires very little effort.

To test the proposed system, an Android application was developed with features for scanning for nearby BLE tags, adding information about the device to Cloud Firestore, reporting an object missing and a map service to locate the object. The Android application also has a background service that will scan for nearby BLE devices. Figure 2 shows a screenshot of the Android application. Whenever a lost object is found, location coordinates of the smartphone which found the lost object will be updated in Cloud Firestore as shown in figure 3. The system was tested and it was able to find many misplaced objects both in a short range and in a long range. The system is reliable and requires very little effort.



(a) (b)

Figure 2: Screenshots of android application. (a) MainActivity (b) MapActivity

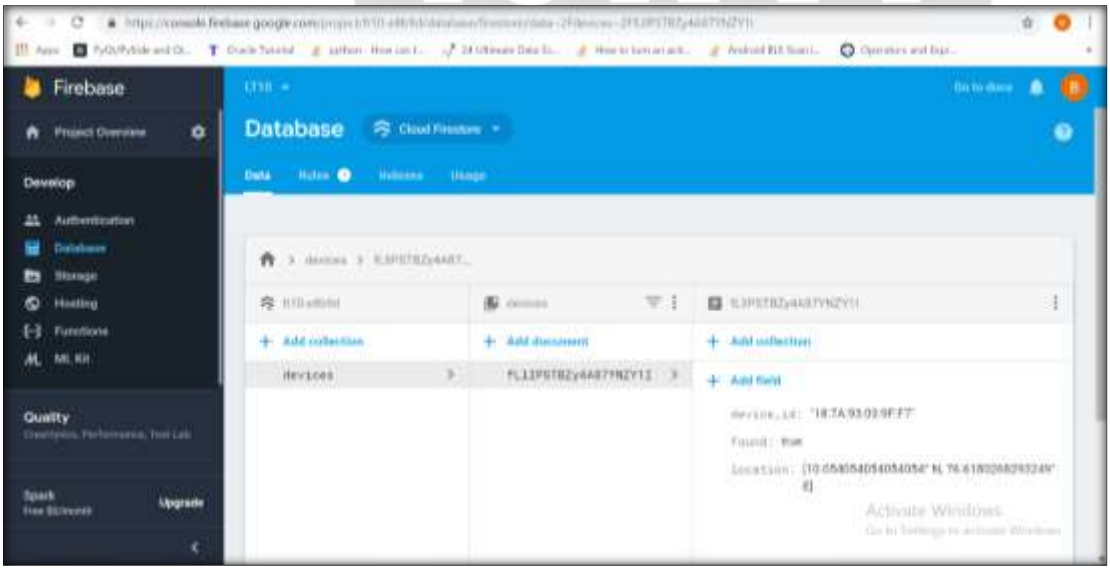


Figure 3: Screenshot of Cloud Firestore console.

VII. CONCLUSION

The invention of BLE tags and given the extreme popularity of smart phones, the BLE-based beacon technology has been deployed extensively as a basis to provide various locating services for smart phone users. It can provide a practical location estimation method for user belongings, both indoors and outdoors. The hard part has been to get a good accuracy of a lost asset relative to the user. Tunnels and subways may offer weak location signals. Tracking the location on a multi floored building is also a challenge. The success of the system is entirely dependent on the number of users. More the number, better will be the ease of tracking the device. A rewarding system can be added to the application in order to attract more users into using the application. As a future work, the system's metric can be enhanced with the integration of mobility prediction algorithms and network community structure for a better accuracy in understanding the future benefits of users to each other. Moreover, for the indoor areas where the GPS information is not available or accurate (e.g. tunnel or underground subway station), the system can be enhanced with complementary solutions based on the proximity analysis between the mobile devices in the vicinity.

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