Special Issue - 2018

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
NCESC - 2018 Conference Proceedings

Bluetooth Low Energy Beacons as Reminders

Prem V
Department of Electronics and Communication,
VVCE, Mysuru, Karnataka,
India,

Rohith. R
Department of Electronics and Communication,
VVCE, Mysuru, Karnataka,
India,

Suchitra. M
Department of Electronics and Communication,
VVCE, Mysuru, Karnataka,
India

Nikhil J Kashyap
Department of Electronics and Communication,
VVCE, Mysuru, Karnataka,
India,

Kevin Costner
Department of Electronics and Communication,
VVCE, Mysuru, Karnataka,
India,

Kavyashree B
Department of Electronics and Communication, VVCE,
Mysuru, Karnataka,
India

Abstract—**The nature of the younger generation and the necessity to react to the environment quickly has made us more memoryless systems. With the help of technology we here provide an efficient way of using a reminder. Bluetooth low energy (BLE) beacons provide a key to this feature.The mobile phone users serve as a node to get connected to a server via a beacon. Mobile phones come under contact with beacon via Bluetooth 4.0 and above versions. By receiving the beacon coverage status from the user's device, the cloud server can react accordingly. We focus on the types of beacons available in the market, their uses and their implications in our proposed project.**

Keywords— BLE beacons, Localization, Server

I. INTRODUCTION

The position of a mobile user can be used to provide various services for the user. Global Positioning System (GPS) is not efficient enough to provide the indoor positioning of an object. Numerous technologies like Wi-Fi, RFID using radio waves and Camera based sensors using optical rays were employed for indoor positioning. They differed in various parameters like Received signal strength, Time of arrival and Angle of arrival. A Comparison between the various technologies is as shown in Table 1. BLE beacons have gained importance and rapid growth after Apple released their iBeacon. They have been used to provide service coupons for the customers who are in the vicinity of the store. The same idea has been modified here and we are aiming to provide notifications of calendar of events for the users in the college.iBeacons were designed specifically for Apple users which made Google to come up with itsEddystone beacons which could be identified by both Android and Apple users. iBeacons transmit identifier in three unique fields called Universal Unique identifier, Major and a Minor while Eddystone transmit them as UID, URL and Telemetric information.

TABLE I. COMPARISON OF VARIOUS TECHNOLOGIES

Technology	Range	Penetration	Feature
Wi-Fi	46 m	Most phones	High detection of visitors
NFC	20 cm	Not all phones	Cannot send push notifications
BLE	100 m	Most phones	Has widespread existing eco system
Geofencing	Outdoor areas	Most phones	Works with RFID, GPS, Wi-Fi

Currently beacons are used as indoor positioning and location based navigational guides, automatic temperature controllers and as advertisers. All of these activities can be realized by manipulating the fixed data that a beacon transmits. In the location based navigation, the App in the user's device notifies the server that it is in the coverage area of the beacon with a corresponding unique ID or the MaC address which it is usually referred as. The server is programmed so as to send the required information to the mobile user so that he can move around within a building with the information received on his mobile device.In an automatic temperature controller the telemetric information transmitted by a beacon is used. An intelligent system is developed to monitor the temperature of a certain area. If there is a mismatch between the pre-fixed temperature and the one received by a beacon, the system performs the required operation to reduce the difference in temperature. In advertisers, they continuously direct the App to get connected to a particular web address through which the relevant advertising information can be sent.

II. LITERATURE SURVEY

Ding-Yu Liu and Co-authors [2] aim at the sensing characteristics that can have more diversified application on IOT. Beacon or Bluetooth Precision Position technology is one such device. The main focus of beacon was to send push notifications to the customers in retail industry in order to expand the business. This paper mainly deals with the iBeacon and its applications. Both Beacon and iBeacon are similar but different in broadcast and frequency. Any device which users Bluetooth low energy (BLE or Bluetooth 4.0) micro positioning signal transmitters can be called as Beacons. In the

micro positioning function Beacon is better than that of GPS. The positioning range could be precisely narrowed down to 2-100 meters and able to identify any mobile phone enters the signal transmission range. It has better advantages in the payment field where Wi-Fi and NFC are used. The basic function of Beacon or iBeacon is that it continuously emits the broadcast signal when a mobile enters the range of the device, Beacon will send a string of codes to the mobile phones after the phone App detects the code, it downloads the information from the cloud or it performs any other related operation t0 obtain the information. The Beacon hardware's connection range reaches 200 feet. Many application are discussed in this paper, the main reason for the increased use of Beacon are dependence on mobile devices. As said earlier it would be used to send push messages to mobile devices within the network range this technology is applicable for indoor venues such as retail stores, large hall and schools.

The main aim of the paper published by Alfonso Bahillo and Co-authors [5] is to monitor the position of handicapped persons. Many citizens get lost or missing in cities, especially the children. There are different kind of positioning techniques for the handicapped people. BLE bracelet integrates a BLE transceiver aiming to broadcast the ID Beacon which unambiguously identifies the dependent. The core of the mobile application is the localization engine which performs seamless localization estimation of the tutor's device in real time by fusing the information collected by all of its sensors. The mobile application allows the confident looking up to the location of his/her handicapped, knowing if they go out of the tutors range, editing alarms in order to better control his/her handicapped and pressing the panic button in case of an emergency.

DaniloCianciulli and Co-authors [3] focuses on mobile crowd sensing and determining the movement of public with help of tracking their mobile phones. The data so obtained is analyzed to make the transportation facilities much effective. In order to achieve this mobile crowd sensing to be done as done in measuring traffic congestion, road conditions, intelligent transport system etc. The paper says thatthis can be done more efficiently with the help of Bluetooth beacons. The following mechanism is chalked out by assuming that mobile can be connected to single beacon at a time and mobile can send the required data to the server at any time. The information gathering is done by client app which is designed as per requirement. Generally it allows sensing the beacons and it also awaits the user to check pre-existing data about the transportation facilities that are provided in the app. The user side app isexpected to distinguish between the beacons installed in a station and the one within the bus itself using the UIDs of the beacon. The mobile that user possess is expected to have the GPS facility so that the station can be located easily. The working happens in three events namely take event, sample event and live event the naming are done with respect to the bus.
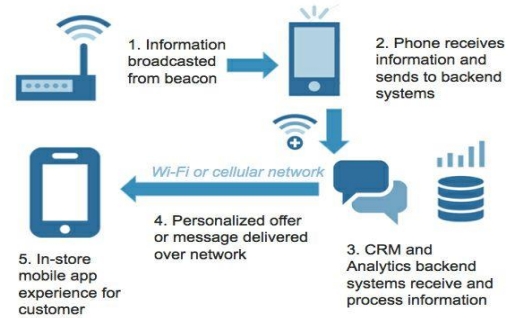

Fig. 1. Beacon Working

III. METHODOLOGY

The working of the system can be categorized into 3 stages, namely beacon configurations, user-side interface and backend server establishment and coding. Beacon configurations refer to the unambiguous positioning of beacons and measuring signal strengths at various points in the coverage area of a particular beacon. The beacon is to be configured to work in the required mode. It can work in three modes, namely, UID URL and TLM modes. The UID mode is where the beacon transmits its Mac address which is similar to that of IP address for computers. With the help of this ID a beacon can be identified and corresponding actions can be taken. In URL mode beacon is made to transmit a particular URL to which the mobile user gets connected automatically if the domain address given exists. The TLM mode of operation is related to the data regarding the environment in which the beacon is deployed. The information like temperature, proximity to the user, humidity etc. are transmitted to the required system. In our proposed project we will be utilizing the UID mode of operation of a beacon. However a beacon is capable of transmitting all the above mentioned information at a time. User-side interface is nothing but the app developed and installed in the user's device to connect to a beacon. We have used Java as a scripting language and html is used to perform the graphical layouts once the app has started. The backend code is written by importing the Bluetooth package. Number of functions are provided in it, but we use the relevant basic functions of scan start and scan stop to detect the beacons within the range. Scan start is provided with dual features; it is made as a constructor but also can be called by the user manually by the button provided in the App. The scan interval is set to 5 seconds in our app. Therefore there must be a minimum of 5 seconds gap between the two successive scan start operation else it would result in an error. The working of the whole system is simplified and is as shown in figure 1.The Bluetooth of the mobile is configured   into our requirements by making a trade-off between the battery capacity and performance of the device. Once the scanning is done and the beacons are detected in a range, we list the beacons with their IDs and the received signal strength (RSS) at that point by the user. The webpage to be displayed is decided by this RSS. We have used NGINX web-server supported by 'Digital Ocean'. MongoDB is used as a database. PHP 5.6 is used to perform the server side scripting. The process of server setting is as explained in the next section.

Special Issue - 2018

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
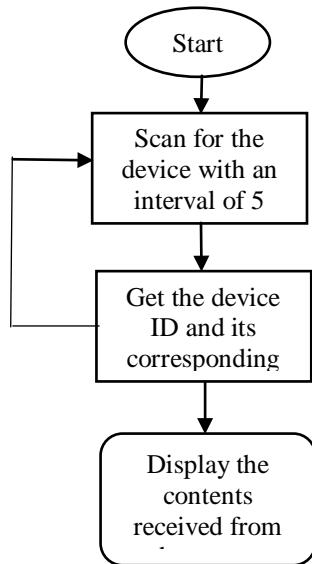**NCESC - 2018 Conference Proceedings**

Fig. 2.   Flow Chart

PuTTY is a Secure Shell (SSH) and telnet client, developed originally by Simon Tatham for the Windows platform. PuTTY is open source software that is available with source code.SSH via PuTTY offers a quick, easy way to securely access a UNIX shell environment from a Windows system. This is handy not only because of the obvious need some people have for working with both Windows and UNIX/Linux systems, but also for both people who are forced to use Windows and want access to the power of the UNIX shell and people who are forced to use UNIX and want the convenience of their Windows environment while they do it. With NGINX having reached such popularity, it makes sense to use NGINX can be used for allweb-serving needs and additionally to take advantage of its capabilities as a reverse proxy server, caching server andload balancer. Once we are set with PuTTY and NGINX, the coding language and its corresponding libraries are to be imported which are termed as repositories. All the spre-existing systems are upgraded and updated so that the advanced features of the language can be utilized. After finishing the above process a webpage should be displayed stating "welcome to nginx" when the IP address provided by the digital ocean is entered in the web-address area. This confirms that the server is established successfully. The sequence of messages that are exchanged between the systems is as shown in figure 3.A database is required to maintain the data which continuously interacts with the server. It is nothing but the organized collection of data. The database used is mongoDb which is classified under NoSQL(originally referring to "non SQL" or "non relational"). A NoSQLdatabase provides a mechanism for storage and retrieval of data that is modeled in means other than the tabular relations used in relational databases. Motivations for this approach include: simplicity of design, simpler "horizontal" scaling to clusters of machines and finer control over availability.MongoDB supports field, range queries, regular expression searches. Queries can return specific fields of documents and also include user-defined JavaScript functions. Queries can also be configured to return a random sample of results of a given size.MongoDB

provides high availability with replica sets. A replica set consists of two or more copies of the data. Each replica set member may act in the role of primary or secondary replica at any time. All writes and reads are done on the primary replica by default. Secondary replicas maintain a copy of the data of the primary using built-in replication. When a primary replica fails, the replica set automatically conducts an election process to determine which secondary should become the primary. Secondaries can optionally serve read operations, but that data is only eventually consistent by default. MongoDB can run over multiple servers, balancing the load or duplicating data to keep the system up and running in case of hardware failure. MongoDB can be used as a file system with load balancing and data replication features over multiple machines for storing files. JavaScript can be used in queries, aggregation functions and sent directly to the database to be executed. MongoDB supports fixed-size collections called capped collections. This type of collection maintains insertion order and, once the specified size has been reached, behaves like a circular queue.MongoDB has official drivers for major programming languagesand development environments. MongoDB is available at no cost under the GNU Affero General Public License, The language drivers are available under an Apache License.
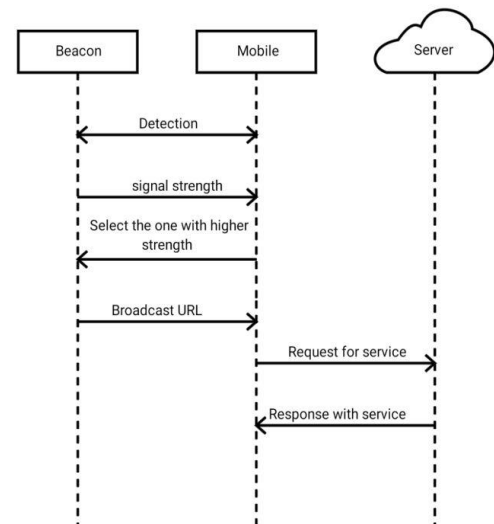

Fig. 3.   Signal exchanges

IV.   CHALLENGES

A beacon is similar to a radio antenna thus it possess various losses while transmitting and there may exist a no coverage region due to radiation pattern. Ideally, the RadiationPattern Specification is provided by the beacon's manufacturer, usually obtained through experiments conducted in typical application environments such as offices, stores etc. Note that the radiation pattern can be different for each check point due to shadowing by any possible barrier in the radiation range of thebeacon. To get more precise radiation patterns, case by case measurements should be performed. Alternatively, the well-known Log Loss Radio Propagation model [4] can be adopted, where the beacon's radiation pattern will be a circle.

Special Issue - 2018

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
NCESC - 2018 Conference Proceedings

$$PL(d) = PL(d0) + 10\alpha \log_{10} \frac{d}{d0}$$

WherePL (d) is the power loss in dB at d meters away, PL (d0) is the reference power loss at d0 meters, and αis the attenuation factor. For BLE beacons, RSSI values are provided by the manufacturers for each power-level in related standards or data sheets, which represents the receiver side signal strength in dBm at d0 = 1 meter away from the beacon. By definition,

$$rssi^k = p_t^k - PL^k$$

Where$rssi^k$,p_t^k, $PL^k$are the RSSI, the transmission power of the beacon, and the first meter power loss at power-level$k \in \{0,1,...,V-1\}$respectively.Another problem is the Beacon Deployment for Unambiguous Positioning (BDUP) problem where each shared information test group has a single test position. Thus the solution of BDUP can serve as an upper bound to the corresponding BDP.

V. RESULTS AND DISCUSSIONS

After performing the skeletal framework of detecting a beacon through an App, the following states were obtained. It shows the Mac address of the beacons and their corresponding signal strength as shown in figure 4. The signal strength shown is of negative value and is in dbm. Thus lesser the value, higher is the signal strength. At the second stage of the project, the beacons were programmed with different webpages and were made to display based on their proximity to the user. One of the pair is as shown in figure 5.Our aim is to send the notification about the ongoing events around the environment where the beacon is deployed. Since the connection is via Bluetooth, there is a chance of signal strength reduction due to presence of any obstacle between the user and a beacon. However the signal strength of another beacon in neighborhood will be much lesser than this one ensuring proper operation. The result obtained is shown in figure 6.
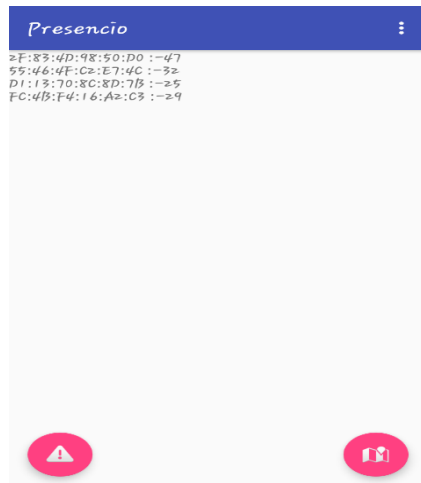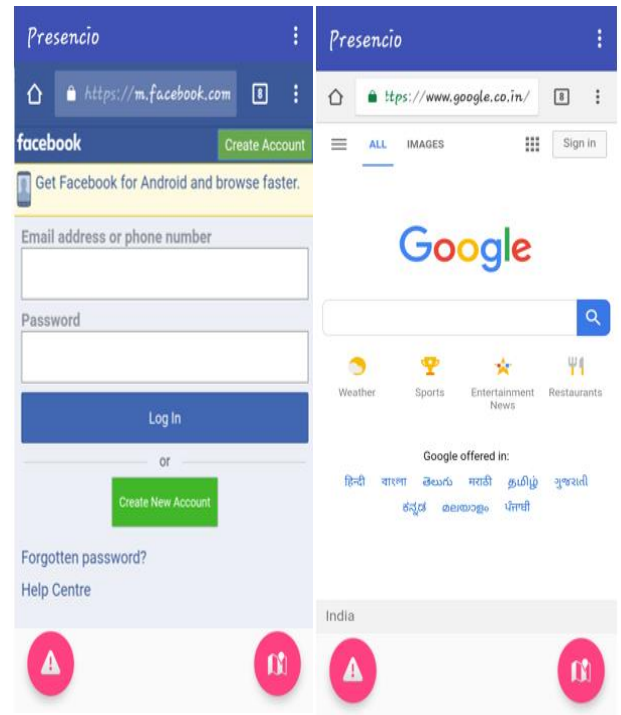

Fig. 4. List of detected becaons

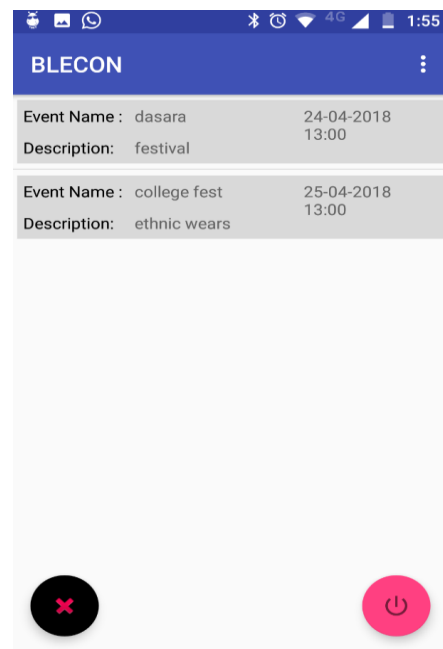Fig. 5. Change of Web page based on Proximity

Fig. 6. Event Displayed

VI. CONCLUSION

Thus the proximity notification is received on a user's device with the help of beacon. The server should be coded in order to send the relevant day's events by checking with the system date or by any other means. The application developed can also be made in such a way to get the message even without entering the App just like a push message. But for this to happen, it should be allowed to run continuously in the background which is taken as a permission while installing this App. Since the Bluetooth associated with this function is

Special Issue - 2018

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
NCESC - 2018 Conference Proceedings

above the version 4.0, the battery life is also expected to be higher than the normal one.

VII. FUTURE SCOPE

The same project can be used as an effective advertising medium. It is the future of proximity based marketing. It can be used in issuing warning messages as well as the information about the animals and monuments in zoological parks and museums respectively.

REFERENCES

[1] AdegboyegaAkinsiku, "BeaSmart: A beacon enabled smarter workplace", Network Operations and Management Symposium (NOMS), 2016 IEEE/IFIP pp: 1269 – 1272.

[2] Ding-Yu Liu, Chia-Sui Wang, Kuei-Shu Hsu; "Beacon applications in information services",International Conference on Advanced Materials for Science and Engineering (ICAMSE), 2016 pp: 438 – 440

[3] DaniloCianciulli, GerardoCanfora, Eugenio Zimeo,"Beacon-based context-aware architecture for crowd sensing public transportation scheduling and user habits", Procedia Computer Science, Volume 109, 2017, pp: 1110-1115

[4] W. He, P. H. Ho and J. Tapolcai, "Beacon Deployment for Unambiguous Positioning," in IEEE Internet of Things Journal, vol. 4, no. 5, , Oct. 2017, pp. 1370-1379

[5] Alfonso Bahillo, Luis E. Díez, Ander Arambarri, BLUE Care: A Cooperative Location Network for Handicapped Persons, Procedia Engineering, Volume 178, 2017, Pages 67-75,

[6] Philipp H. Kindt; Marco Saur; Michael Balszun; SamarjitChakraborty; "NeighborDiscoveryLatency in BLE-LikeProtocols", IEEE Transactions on Mobile ComputingYear: Volume:17, Issue: 3, 2018, pp 617 - 631.

[7] C. Xiao, D. Yang, Z. Chen and G. Tan, "3-D BLE Indoor Localization Based on DenoisingAutoencoder," in IEEE Access, vol. 5, 2017, pp. 12751-12760.

[8] I. Radoi, G. Gutu, T. Rebedea, C. Neagu and M. Popa, "IndoorPositioning inside an Office Building Using BLE," 2017 21st International Conference on Control Systems and Computer Science (CSCS), Bucharest, 2017, pp. 159-164.

[9] Kevin Bouchard, RaminRamezani, ArashNaeim, "Features based proximity localization with Bluetooth emitters", Ubiquitous Computing Electronics & Mobile Communication Conference (UEMCON) IEEE Annual, 2016, pp. 1-5.

[10] Andrei Popleteev, "Indoor Localization Using Ambient FM Radio RSS Fingerprinting: A 9-Month Study",Computer and Information Technology (CIT) IEEE International Conference on, 2017, pp. 128-134.

[11] YukiharuMotohashi, Eri Sato-Shimokawara, Rosanna Yuen-Yan Chan, Nan Zhou, Toru Yamaguchi, "Using iBeacon to detect user behavior from indoor physical movement", System Integration (SII) 2017 IEEE/SICE International Symposium on, , 2017, pp. 799-804, ISSN 2474-2325.

[12] Po-Hsuan Tseng, Yao-Chia Chan, Yi-Jie Lin, Ding-Bing Lin, Nan Wu, Tsai-Mao Wang, "Ray-Tracing-Assisted Fingerprinting Based on Channel Impulse Response Measurement for Indoor Positioning", Instrumentation and Measurement IEEE Transactions on, vol. 66, 2017, pp. 1032-1045.