



SMART SHOPPING USING BEACONS

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Abstract

Internet of Things (IoT) is a paradigm shift driven by the recent evolution in the world of sensor networks, mobile equipments, wireless communications and cloud technologies. IoT brings about the possibility to use technology and automation in daily life which opens up possibilities of innovative business models. Bluetooth Low Energy (BLE) is a technology that provides location based services for cost-effective communication within a given range. This paper concentrates on the use of this technology in retail markets. BLE extends the capabilities and accessibility of smartphones and aids retailers to offer services to customers depending on their in-store communication with the products. The proposed system will utilize motion sensing, proximity sensing and machine learning algorithm for personalizing and improving customer experience in retail stores.

Index Terms: Internet of Things (IoT), Motion Sensing, Proximity Sensing, Machine Learning, Retail.

I. INTRODUCTION

The Internet of Things(IoT) is a standard of communication in which everyday objects are equipped with sensors. IoT is being put into effect in every domain of human concern like traffic navigation, security, smart agriculture, home automation, retail and healthcare. Beacon Technology is one such aspect of IOT. Retail is currently the most popular area in which beacon technology is being implemented. Beacons provide a modern way for interaction between customers and retailers in a store.

Due to the increasing popularity of online shopping, offline retail stores are facing threat of being obsolete. As a result, retailers are making

an attempt to integrate technology in offline shopping. Mobile devices play a significant role in connecting retailers to their customers. Understanding the behaviour of the customer within the retail store is crucial for providing ideal shopping experiences, ensuring optimal layout, and developing an efficient operational model. Marketing to customers at the right time based on their location has the potential to cause a paradigm shift in retailing.

Bluetooth Low Energy is a wireless technology for short range communication requiring low power consumption. BLE devices can be used to monitor and track other devices within range and this capability can be used in retail to improve customer experience. A mobile application design to interact with the beacons offers a number of benefit to the customers as well as retailers. Since beacons are designed for mass distribution and operate on a coin-cell battery, these tiny devices can be placed throughout a retail store at walls or on products enabling customers via the application to be notified of recommendations, greetings, special offers when they enter the store or provide specific product information of items depending on their in-store actions or proximity with the products.

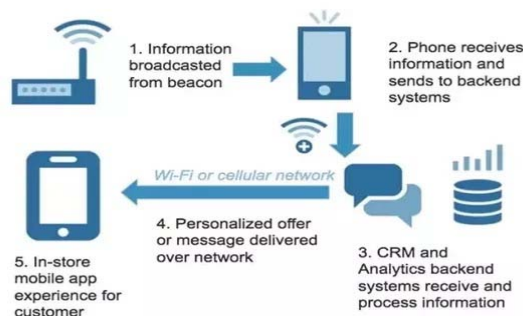


Fig. 1. Working of BLE beacons (Source : www.empresario_zcapital.com/files/6214/3292/6082/beacons1.jpg)

There have been numerous applications using beacons in bookstores, airports, retail stores, etc. We will be focusing on the use of beacons in retail stores in this paper. This paper discusses the usage of the motion sensing and proximity sensing features of beacons in retail applications. To exhibit motion sensing, the beacons will be attached to products and will transmit signals only when the customer picks up or moves the product. Proximity sensing in beacons will be used to recommend products to customers when they visit the store based on their purchase history by attaching beacons at the doors of the store. This methodology is discussed in detail further.

II. RELATED WORK

[1] carries out a survey about the consumer attitude towards beacon-based services among a sample of consumers in Germany to understand it better. The purpose of the survey was to explore the interests of the end consumers in beaconbased services and their willingness to use those services. It was found out that that there was a large acceptance for the beacons among the participants of the survey.

[2] explains how indoor spaces block cell signals which makes GPS, RFID futile. It illustrates how Bluetooth beacons can be used for indoor mapping and proposes how the Bluetooth beacons can be beneficial to retailers in terms of customer analytics, operational analytics and revenue improvement. Retailers can combine real-time, contextual information and advanced analytics to determine and deliver the best offers to customers.

[3] proposes an android based application implemented for bookstores and libraries. The system sends recommendations to the user about the books using various algorithms. A beacon is attached to each shelf of the bookstore and when a customer enters the range of the beacon, the python application analyzes data and ranks recommendations using purchase history or social media data. If recommendations are present, they are sent to the customer or it gives the shelf number where recommendations can be found.

[4] explores Beacon on a variety of applications in information services such as traditional library service. It illustrates how digital reading can be promoted in venues like bookstores or cafes. Beacons can be installed at the entrances which recommend e-books of

related themes. Recommendations like how many people in the region are reading the same book can be given as an additional feature.

[5] describes the basic principle of i-Beacon and address a design of interaction system between visitors and collections supported by the i-Beacon technology. Beacons can be placed behind collections or in the lobby which will provide visitors history and background of the collections and also help them navigate through the museum. This will help make the experience at the museum enjoyable.

[6] proposes a proof of concept for a mobile application which uses BLE beacons to provide assistance for people with special needs. It aims at providing an easy to use voice interface for navigating inside stations, buses and trains. It also allows caretakers to plan and register trips for people with special needs and can also track the trip in real time. [7] proposes the use of BLE Beacons to determine peoples movements while entering, departing or passing by a room based on received signal strength over time.

[8] proposes that connecting all devices together using technology like IoT can make human lives better and more efficient. New firms adopting this technology can gain a competitive advantage over other firms using capabilities and advantages of IoT.

[9] gives information about the new marketing trends being adopted by companies. It explains the use of beacons in various applications like airports, hotels, safety, banks, etc. It also shows statistics of how consumers prefer personalized offers, recommendations instead of specific products.

[10] explores various factors affecting consumer behavior towards proximity sensors within a retail store. Survey of South African retail market about factors like effect efficiency, performance expectancy, price value, habit, etc revealed that among all factors, price value was relatively insignificant.

[11] discusses its enhanced BLE based proximity, optimized resource consumption, and manageability of beacon devices and using it for a wide range of business sectors such as retail store, public place, hotel, hospital and home.

III. EXISTING SYSTEM

Most of the existing systems use the proximity sensing and the location based services of the beacon. The applications implementing these

features are used at various places like libraries, airports, malls, retail stores etc. to provide location specific information to the users. For example, a user may receive product recommendations while sitting at home or get information of all the products in their proximity at their fingertips while passing by a retail store, without even having to enter the store at times. However, this system has a flaw. User might not be interested in shopping but keeps receiving unnecessary notifications which can be bothersome. It might also be possible that the customer does not require information about all the products but only a specific product they are interested in. This bombardment of unneeded notifications can weaken the customer base.

IV. PROPOSED SYSTEM

The proposed system tries to eliminate the drawbacks by using proximity and motion sensing in an effective manner. The system uses motion sensing to provide product details to the customer based on their in-store actions thus avoiding inessential relay of data. It also integrates proximity sensing to provide user recommendations when they enter the store based on their past purchases.

A. System Architecture

As shown in figure 2, the system consists of three basic elements, the server, which consists of the databases, the system modules and the user interaction with the android application and beacons. The databases store customer details, product information, order details, etc. The system modules have been explained later in the paper. The interaction of user with the system provides necessary input to be given to the processing modules. Every beacon stores product information corresponding to its beacon ID on the server.

Some of the beacons are attached to the products that are kept for display in a store and some are attached to the store entrance for user recommendations. These devices transmit radiations at regular intervals. The customers must have a BLE compatible smartphone with the application installed.

Depending on the customer activities, the three elements communicate with each other and work in a cohesive manner to provide necessary details and recommendations thus improving the customer's shopping experience.

Also, this customer interaction with the product will be used to gain valuable insights of the customer's behavior. The analytics module will provide owners with valuable statistics that can aid the retailer decide new business strategies.

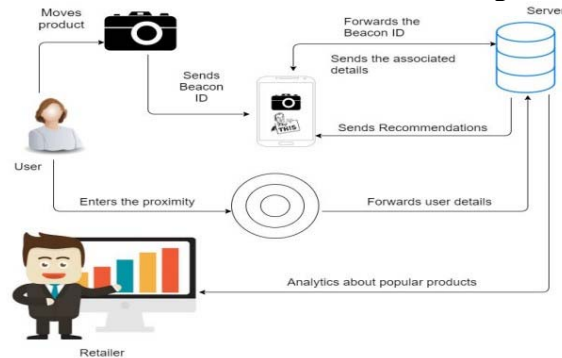


Fig. 2. System Architecture)

B. System Design

- Hardware : Beacon (Estimote)
- Software : Windows OS, Android Studio, Estimote SDK, Python, PHP, MySQL
- Communication : BLE specifications

C. System Modules

- Beacon Advertisement by the Beacon Hardware
 - The beacons have been developed by Estimote which has its own website and mobile application where beacons can be configured as per the use of the application. We configured the beacons by changing settings such as enabling the estimote telemetry and setting broadcasting power and advertising intervals to appropriate values.
- Customer Login and Registration from the Mobile application
 - On the backend we have a MySQL database where the details of the registered users will be stored and the users will have their own account which they can manage.
- Processing of Beacon information
 - The android application is always scanning for telemetry packets. Whenever an user moves a product the android application detects the telemetry packet using the telemetry listener function present under the Estimote SDK. It then extracts the device id from the packet and makes a post request to the database using PHP script. The PHP returns the JSON encoded response back to the android app.

- Display of product details
 - The android application decodes the json encoded string and retrieves the necessary information. It then displays the details by enforcing it on an XML file built in android, which provides the necessary formatting to the details.
- Analytics module
 - The customer trends obtained are analyzed to provide retailer valuable information about popularity of products which can aid to change the store layout and improve sales.
- Recommendation module
 - It uses machine learning algorithm to provide recommendations to the users when they visit the store. It uses item-item collaborative filtering method to suggest products to the user. This method is based on the similarity between items which is calculated using people's ratings for those items. It is analogous to "people who rate item X highly, like you, also tend to rate item Y highly, and you haven't rated Y yet, so you should try it". The cosine similarity is calculated as:

$$1 - \frac{u \cdot v}{\|u\|_2 \|v\|_2}$$

where u and v are vectors

D. Design Constraints and Assumptions

- Connectivity affected due to obstacles : If there is any solid object such as a wall between the beacon and the mobile device then this will subside the signal strength [3]
- Range of beacons depends on Hardware used : The range within which the beacon id is transmitted may vary depending on the hardware used in its making [3]
- Requirement of devices supporting BLE Specification (Android version 4.3 or above): Due to high variations of android platform across different types of hardware, not all android devices will fit the minimum requirements for the service. [3]
- Cost : If the beacon requirement is not a mass production and produced on a small-scale then the project will not be financially feasible

E. Proposed Algorithm

- 1) Start
- 2) The Android application will turn on Bluetooth and location services

- 3) When the customer visits the store, if they enter the proximity region of the beacon, get user ID and goto 7) else goto 4)
- 4) When the customer picks up a product, get ID of beacon associated
- 5) Pass the ID to a server
- 6) Fetch product details corresponding to the ID and display it and go to 11
- 7) Read the csv file and create an association matrix between user and the products
- 8) Create vectors using the user ratings for the products
- 9) Calculate similarity between products using cosine similarity
- 10) Calculate the product rating for a particular product by a particular user using weighted average method
- 11) Stop

F. Flowchart

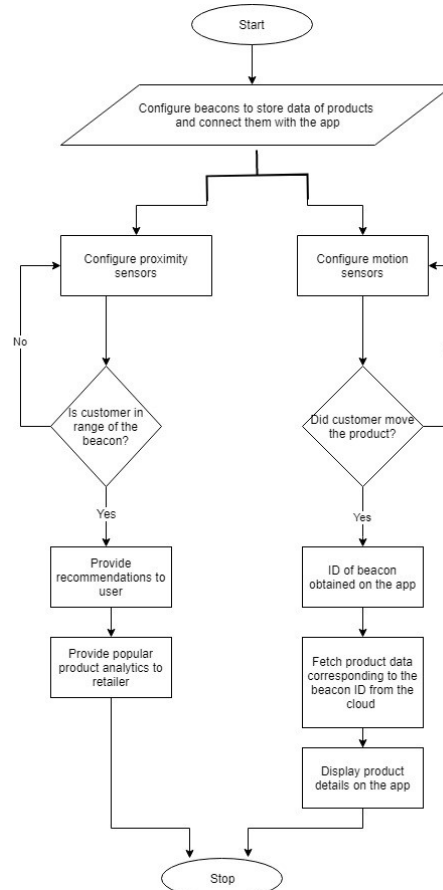


Fig. 3. System Flowchart

G. Implemented Application

The working model involves each of the above mentioned system modules. As the application starts the user is asked to register if he/she is a new user or login if the user has already registered. Once the user logs in to the

application, the user is then requested to enable the bluetooth and location services if they are previously disabled.

There are two aspects to the application, proximity sensing for recommendation and motion sensing to provide product details. As soon as the customer enters the proximity region of the beacon, it uses the user ID to obtain purchase history and provide recommendations. Once any user moves or picks up a product, the user receives a notification on the mobile device. When the user opens the notification he gets all the details of the product he picked up or moved along with the option of buying it.

V. CONCLUSION

On evaluating various features of beacons, some of them being motion sensing, proximity, location, humidity, we found an effective way to integrate some of these features in a single application to provide customers a more seamless and convenient shopping experience. The proposed system will help the retailers exist in a competitive environment and also increase their sales.

By using their smartphones, customers already switch between online and offline channels, e.g. to check the online prices or to obtain product information. Also, there is no absolute guarantee in the quality of products in online shopping. The information obtained from websites can be faulty or deceiving. This makes offline shopping more reliable. Users are provided context specific information on their smartphones without them having to check details on various websites. This helps to reduce the dependency of customers on the store attendants.

To corroborate the effectiveness of the application, we conducted a consumer survey and found out that more people prefer to receive details about a product in shopping applications only when they are interested in the product.

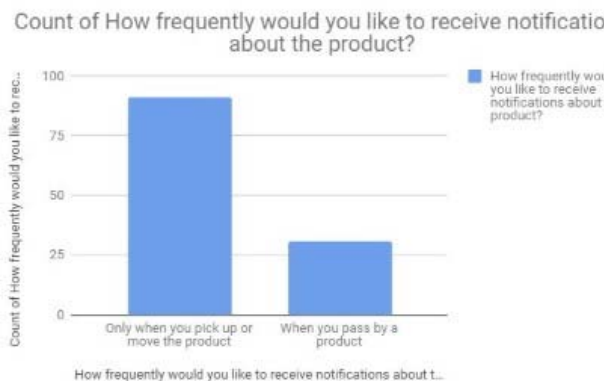


Fig. 4. Survey

Thus, the system incorporates beacon technology in retail with an aim to upgrade customer shopping experience and aids retailers improve their business model.

Out of the numerous times we tested the system, 80% of the time, the application detected the beacons and fetched corresponding product details immediately. However, there were times when the system experienced delay of upto 100120 seconds in detecting the motion of the beacons. The overall performance of the system was satisfactory.

VI. FUTURE SCOPE

The scope of our project can be extended by integrating the indoor positioning services provided by the beacons to help the customer navigate through the store which is not possible through GPS.

Also, temperature and humidity features of the beacons can be used in grocery stores to provide retailers information about the freshness of the current stock.

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