International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 04 | April - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Shopping Mall Experience Over E-commerce Websites Using Beacon Technology and Data mining Algorithms

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Abstract:

The dramatic change in shopping experience over the past few decades presents many challenges to the retailers. In this technology can play an important role in enriching the shopping experience for the customers and help increase the sales of the retailers. In this paper an innovative method for doing the same is proposed. In this proposed system, customers are tracked using beacons that are set up in the retail shops and personalized discounts are offered to the customers based on their shopping patterns and purchase histories. The smartphone application detects the location of the customer inside the shop using Bluetooth Low Energy (BLE) signals emitted by the beacons and the information is then sent to the server for processing. The server then sends personalized offers to the customer. A Beacon is commonly a little Bluetooth Low Energy (BTLE, Bluetooth 4.0) gadget that can be controlled by a coin cell, batteries or through an outer power supply. Beacon is expertise in identifying proximity and can be used in business areas for various information. The data which beacons transmit will be in the form of packets and relevant Smartphone can take up the data which is transmitted. In the proposed system the customer will receive the notifications and services provided by the vendor when he passes near the store/mall, thus providing the customized advertisement service to the user. This paper review beacon technology in the aspects of its roles, merit and demerit.

Keywords: Beacon technology, Cluster analysis, Data management systems, Electronic commerce, Internet of things and Unsupervised learning

I. INTRODUCTION

Over the years, there has been a monumental growth in sales as well as popularity of e-commerce websites [1]. 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.The ecommerce websites draw advantage of resources such as continuous digital presence, virtual shopping, convenience and personalized shopping experiences, through the means of target-based advertising and data analysis approach [1]. This has put the brick and mortar shops at a disadvantage. In order to overturn this disadvantage, substantial
efforts are being made by retailers. These include steps like providing an individual digital application (with the same working model as e-commerce website), for different shops to achieve the aforementioned goal. Some shops have also dabbled with the approach to create their own digital interface which includes a website as well as a mobile application to challenge the giants of e-commerce. But this hasn't yielded the desired outputs and the proposed system envisions to overcome the disadvantage.
Now, beacons have brought about a revolution by introducing Geo-marketing [2].
Geo-marketing works by integrating geographical intelligence along with display-plan review form of marketing and sales activity. Thus, the location determined with the help of beacons can make or break this form of advertising. Hence, beacons are used as they provide a more accurate and real time location in comparison to GPS [2] [3] [4]. This application makes use of three technologies listed in the following order - beacons (to target and detect customers), android application (to create a digital platform for user interaction) and data analysis algorithms (to deliver personalized shopping experience).
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 behavior 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.

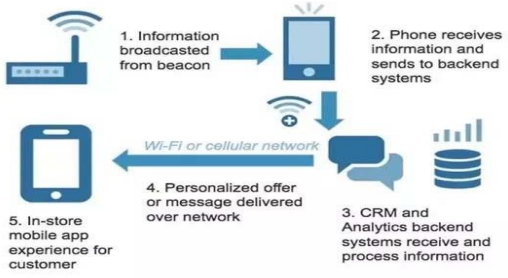

Fig. 1. Working of BLE beacons
(Source : www.empresario_zcapital .com/files/6214/3292/6082/beacons1.jpg)

II. RELATED WORK

In the existing System with the prevalence of service computing and cloud computing, more and more services are deployed in cloud infrastructures to provide rich functionalities. Service users have nowadays encounter unprecedented difficulties in finding ideal ones from the overwhelming services.

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 beacon based 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.

Recommender system (RSs) are techniques and intelligent applications to assist users in a decision-making process where they want to choose some items among a potentially overwhelming set of alternative products or services.

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.

The cluster analysis gathers users with similar characteristics according to the web visiting message data only. Much time to search and data clustering Management is poor performance.

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.

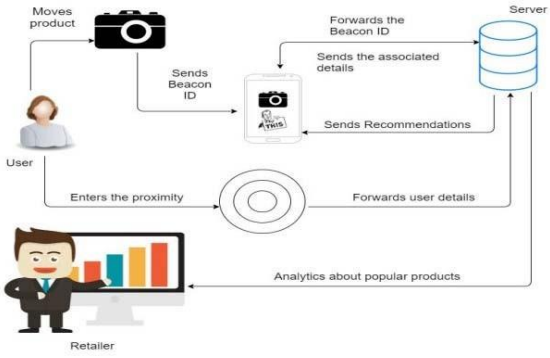

Fig. 2. System Architecture

B. Preprocessing

Preceding to the three main parts of the system, the user is tracked using his GPS [4] location through a process called Geofencing. Geofence is similar to a virtual boundary around any geographical area, and is defined with the help of GPS [13]. It enables the application to trigger a response when a particular mobile device
enters or leaves the geofenced area.

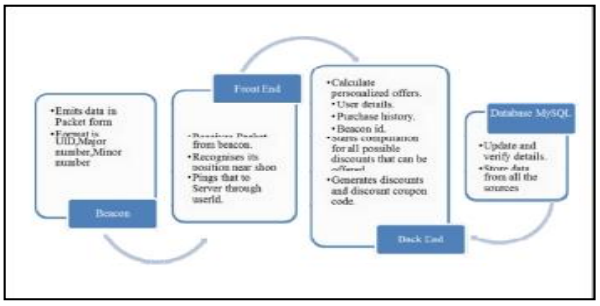

Fig .3. Pre-processing System

Geofencing is used to track user outside the shop. Here, the geofence is dynamically generated using the user's location. The latitude, longitude and the radius are the parameters used to create a Geofence around the shop. The radius parameter is set at a radius of 2km. A push notification is sent to the user as soon as the user is detected in the Geofence area [2][13]. The Geofence area is typically set around the shop. The push notification can be set to variables such as indicating current discounts or the sales in the shop. Fig.1. explains the flow of the proposed system.

C. System Design

- Hardware: Beacon
- Software: Windows OS, Python, MySQL
- Communication: BLE specifications

D. System Modules

- 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.

- Analytics module
  - The customer trends obtained are analysed to provide retailer valuable information about popularity of products which can aid to change the storelayout and improve sales.

E. 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]

Fig. 4. System Flowchart

F. 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 is 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.

G. Algorithm Working and analysis

- **FP Growth Apriori Algorithm:**

This algorithm is an improvement to the Apriori method. A frequent pattern is generated without the need for candidate generation. FP growth algorithm represents the database in the form of a tree called a frequent pattern tree or FP tree. It works on the principle, "the non-empty subsets of frequent item sets must also be frequent". It forms k-itemset candidates from (k-1) item sets and scans the database to find the frequent item sets. Frequent Pattern Growth Algorithm is the method of finding frequent patterns without candidate generation.

Let I = {i1, i2, . . . , in} be a set of n binary attributes called items. Let D = {t1, t2, . . . , tm} be a set of transactions called the database. Let R = {r1, r2, . . . , rk} be a set of k density regions. Each transaction in D has a unique transaction ID, a region where the product was purchased, and contains a subset of the items in I. A rule is defined as an implication of the form:

r: X→Y, where X, Y⊆I and r⊆R.

In order to select interesting rules from the set of all possible rules, constraints on various measures of significance and interest are used. The best-known constraints are minimum thresholds on support and confidence. Let X, Y be itemsets and r be regions, r: X→Y an association rule, and T a set of transactions of a given database. **Definition 1. (Support)** Support is an indication of how frequently the itemset appears in the dataset. The support of X with respect to T is defined as the proportion of transactions t in the dataset which contains the itemset X.

supp(X, r) = |{t∈T; X⊆t}|/|T|, where T. region = r

The support gives an idea of how frequent an itemset is in all the transactions.

Definition2. (Confidence) Confidence is an indication of how often the rule has been found to be true. The confidence value of a rule, X→Y, with respect to a set of transactions T, is the proportion of the transactions that contain X which also contains Y.

conf(X→Y,r)=supp(X∪Y)/supp(X), where T. region = r

We modified by adding the locality of the transaction to the support and confidence used in the existing association rule. For conciseness of expression, however, it is expressed in the same way as support and confidence. Problem definition. Given a set of transactions, D, containing regions where the items were purchased, the problem of mining association rules is to generate all association rules that have support and confidence greater than the user-specified minimum support (called minsup) and minimum

confidence (called minconf) respectively for user-specified regions

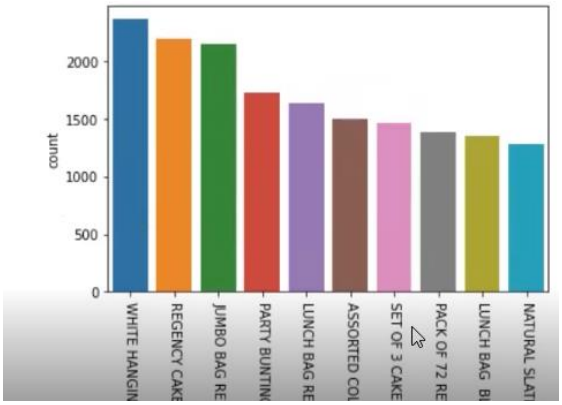

Fig 5. Analysis of FP Growth Algorithm

- **K- Means Algorithm:**

K-means clustering **uses** "centroids", K different randomly-initiated points in the data, and assigns every data point to the nearest centroid. After every point has been assigned, the centroid is moved to the average of all of the points assigned to it.

In this project, the clusters are formed based upon the number of sections in each shop and how many times the user has shopped in the section. Once the clusters are formed, pre-defined slabs to calculate the discounts are then used to make offers for the customers. Then, the current beacon id of the beacon is then used to find the products that are in the vicinity of the customer. The personalized discounts for these products are then generated and sent to the application [6][8]. In order to prevent notification overloading, the discounts are not sent as notifications but displayed in the application along with the product information [2][6][7]. This completes the data analysis on the server side and the final list of data is sent to the application for display.

$$J(V) = \sum_{i=1}^{c} \sum_{j=1}^{c_i} (\|x_i - v_j\|)^2$$

where,

'$||x_i - v_j||$' is the Euclidean distance between x_i and v_j.

'c_i' is the number of data points in i^{th} cluster.

'c' is the number of cluster centers.

Algorithmic steps for k-means clustering

Let X = {x_1, x_2, x_3, …….. , x_n} be the set of data points and V = {v_1,v_2,…….,v_c} be the set of centers.

1) Randomly select 'c' cluster centers.

2) Calculate the distance between each data point and cluster centers.

3) Assign the data point to the cluster center whose distance from the cluster center is minimum of all the cluster centers..

4) Recalculate the new cluster center using:

where, 'c_i' represents the number of data points in i^{th} cluster.

$$v_i = (1/c_i) \sum_{j=1}^{c_i} x_i$$

5) Recalculate the distance between each data point and new obtained cluster centers.

6) If no data point was reassigned then stop, otherwise repeat from step 3).

Serial Number	*Tags*	*Frequency*
1	Furniture	4
2	Men's Clothing	1
3	Women's Clothing	1

Fig. 6 Output of K- Means Algorithm

V. CONCLUSION

In this paper, a system has been proposed that can be used by the retail shops to provide better service and enriching shopping experience to the customers. The system proposed, saves the time wasted in bargaining with the shopkeeper, by providing a range of best possible offers to the customers. This technology if adopted by the retailers can surely improve the customers shopping experience and also help the retailers to increase their sales by providing more personalized offers to the customers. Also this paper reviewed new possibilities for improving marketing and retail practices by implementing IoT solutions. 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 system also makes the provision for the retailer to study and understand the customer's shopping and spending pattern. This may help the retailer in better inventory management as well as customer management.

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