LiFi based automated shopping assistance application in IoT

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Abstract. Urban people minimize shopping time in daily life due to time constrain. From that point of view, the concept of supermarket is being popular while consumers can buy different items from same place. However, customer spends hours and hours to find desired items in a large supermarket. In addition, it’s also required to be queued during payment at counter that is also time consuming. As a result, a customer has to spend 2-3 hours for shopping in a large superstore. This paper proposes an Internet of Things and Li-Fi based automated application for smart phone and web to find items easily during shopping that can save consumer’s time as well as reduce man power in supermarket.

1. Introduction
Modern people are so engaged with multiple daily life activities. Maintaining family, office, business and personal life, sometimes it is very hard for city dwellers to spend time shopping. From that corner, the supermarket is one of the part and parcel in modern life. People prefer shopping from supermarket where cloths, groceries, toiletries, jewellery and so on items are able to buy from same place [1-2][5]. Since customer buy different items from different corner in a big supermarket, however, it is possible to pay in a one stop counter. Such kind of facilities of a super market has drawn attention of busiest customers [3-4]. As a consequence urban people usually go to supermarket for daily shopping.

While people are busy with their own activities, most of the time, many of them prefer do shopping during weekend. Unlike during weekend many of them go for shopping, as a result, supermarket are always crowded. In a big supermarket, it is also time consuming to find desire items. In a result, a customer has to spend 1-2 hours to pick their items into trolley. Besides that, there is a long queue during payment while it is crowded. To sum up, the whole process unnecessarily took important hours of customer’s daily life.

In this paper, Internet of Things (IoT) and Li-Fi based an automated application has been proposed that helps a customer to find the items from different rows. In addition, it will list down and calculate the price of items and save shopper’s time during payment. The next portion of this paper explains the proposed architecture of this application. The following part elaborates the evaluation of proposed work and benchmark the coding structure of this proposed work.
2. Architecture
This application can be proposed in two different versions, web and mobile version. Customer and cashier interface are main two parts of this application’s architecture. Figure 1 shows the different modules of this application.

![Figure 1. All modules.](image)

2.1 Customer Interface
The customer interface contains few stages. Users are able to create shopping list. Application will assist the list of items by showing row location. Customers are able to get the item’s price by scanning barcode using smart phone. At the end of the shopping customer’s will get the total price that need to be paid.

Every time a new customer enter in supermarket territory, a free LiFi based internet connection available to connect. The default landing page is the supermarket’s online application where user are able to create a new list of item that they need to buy.

2.1.1 List. In application, users are able to create a shopping list. Based on user’s device IP and MAC address [7], a new list will be generated for a newly connect user that will connect in central database though LiFi and IoT [13]. Based on different user, application automatically create a unique number for each that can be tracking number during payment and reference. Based on availability of product in the super market, users are able to key-in at shopping list. The list of the item will be auto suggested in shopping list that can assist buyer to choose as well. Figure 2 shows the database table design for item list.
2.1.2 Destination Assistance. In application, users are able to create a shopping list. Based on user’s device IP and MAC address [7], a new list will be generated for a newly connect user that will connect in central database though LiFi and IoT [13]. Based on different user, application automatically create a unique number for each that can be tracking number during payment and reference. Based on availability of product in the super market, users are able to key-in at shopping list. The list of the item will be auto suggested in shopping list that can assist buyer to choose as well. Figure 2 shows the database table design for item list.

\[
(3959 \times \cos(\text{radians}(37)) \times \cos(\text{radians}(\text{lat})) \times \cos(\text{radians}(\text{lng}) - \text{radians}(-122)) + \sin(\text{radians}(37)) \times \sin(\text{radians}(\text{lat})))
\]

**Code 1.** Code for detecting nearest coordinate.
2.1.3 Product Checkout. Users are able to self-checkout the product by using their smart phone. In application, user are able to scan the product barcode and store the barcode number next to the respective item [9]. Based on product’s barcode, the price will be added where list will be checked after scanning all the item’s barcode. At the end of the procedure, the total price of the shopping will be displayed.

2.2 Cashier Interface
The cashier interface is total control in cashier side. It shows the current active customers who has completed shopping list by scanning barcode. Cashier in-charge can able to search a user by tracking number that was generated during creating a new shopping list at the beginning.

2.2.1 Paying at Counter. At the stage of check out from the supermarket, user need to confirm at cashier counter. Cashier in-charge are able to see the list of the current active customer based on nearest location from the cashier’s geo location. Apart from that, cashier in-charge are able to find a user by customer’s tracking ID. To find the nearest customer, octree algorithm has been used [10-11].

Code 2 shows the pseudo code of octree algorithm.

1. \( X = Q.X \)
2. \( Y = Q.Y \)
3. \( Z = Q.Z \)
4. \( X = Q.X + \text{cubeSize} \)
5. \( Y = Q.Y + \text{cubeSize} \)
6. \( Z = Q.Z + \text{cubeSize} \)

**Code 2.** Pseudo code of octree algorithm.
2.2.2 Payment Gateway. There are 3 types of payment methods has been proposed for this application, card, mobile banking and cash. Cashier helps customers to swap the card or confirm the mobile payment gateway or charge by cash on spot. Based on cashier’s confirmation, a bill will be generated and printed for customer from central database with the help of IoT.

3. Design Pattern and Benchmarking

To implement the proposed application, PHP / Python / Java will be used as a code programming language. Beside this, Angular JS, React JS, VueJS, Pusher, Socket.io, Radis will be used for making the application real time.

Since it’s a large application and everyday there are lot of customers, the big data is the huge concern for this application. The mysql will be used to store the data. In order to optimise the big data, mysql data driven model will be used [12][14]. The whole application will be stored in a central database from where all the data will be represented with the assist of IoT.

The xhprof will be used in order to benchmark the whole application [11][13]. **Code 3** show the benchmarking pseudo code for testing unit of application performance.

> use xhprof

    db.results.ensureIndex( { 'meta.SERVER.REQUEST_TIME' : -1 } )
    db.results.ensureIndex( { 'profile.main().wt' : -1 } )
    db.results.ensureIndex( { 'profile.main().mu' : -1 } )
    db.results.ensureIndex( { 'profile.main().cpu' : -1 } )
    db.results.ensureIndex( { 'meta.url' : 1 } )

**Code 3.** Benchmarking code by xhprof.

4. Conclusion

Although people are spending money for shopping, however, sometimes it becomes very difficult to spend time for that. In such kind of cases, customers prefer easiest way for shopping. In order to mitigate customer’s searching and waiting time in super market, the proposed application can contribute tremendously. This application provide flexibility to customers to choose either web or mobile application for smoothly uses. Since this application assist customers to find out desire shopping item by calculating congesting time of current situation and self-checkout, intimately that can save 2-3 hours of a weekly customer’s shopping time.

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