SMART SHOPPING SYSTEM USING LIGHTWEIGHT IoT PROTOCOL

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***Abstract*— As the constant innovations in technological advancements are increasing, we are seeing new developments in different fields including machine learning, man-made consciousness, web of things, etc., there is an expansion in the desires in the purchaser perspective. With the quick moving lives, the buyers totally have no opportunity to remain in long lines so as to complete their work. In this paper, we are presenting a smart shopping system using ultrasonic sensor, PIR sensor and Raspberry Pi controller. The trolleys in the shopping malls are protocoled so as to automatically bill the products put into them and the final bill is sent to a mobile application which can be accessed on any phone or any hand-held device, the communication takes place through MQTT protocol. The framework additionally enables a faster and effective billing process.**

Keywords—Raspberry pi, Ultrasonic sensor, PIR sensor, MQTT protocol.

I. INTRODUCTION

Smart is the trending word in IoT at present. Every aspect of human life made simple by the use of machines is transformed into this smart-machine that makes our work even easier to manage. The increase in Internet technology has brought all the food items at our doorsteps whenever needed. But the experience of going to a mall and shopping the products all by ourselves has its own advantages and disadvantages as well. The advantages include careful selection of the best product according to our convenience and analyzing the touch and feel of it. The major drawback however id the stretched-out line of customers for paying the bill which nowadays is becoming really hard to manage. The brought forward smart shopping structure avoids this drawback and also has additional features for the convenience of the consumer. The intensified Smart Shopping System helps the customers in minimizing the considerable amount of time that they spend shopping. In this system, real-time updates on the inventories are provided in the store management section. The main technologies that play a vital role in this proposed system are: (i) Raspberry Pi for achieving wireless communication with Server (ii) Ultrasonic Sensor (iii)PIR sensor (iv) Mobile application displaying amount payable and managing the inventories detail. The Smart Shopping System with the Smart Cart has the potential to make smart shopping easy, congenial, amiable and systematic to the customers, it also makes it easier for the store management to handle the inventories .The user can easily pick an item and specify the amount of quantity that product will be added directly to the mobile application. It is a sort of mix between online and offline shopping that hugely affects the rate of billing service.

II. COMPONENTS SPECIFICATION

A. Raspberry pi

The model Raspberry Pi 3B+ is the newest and most upfront production. It features a 64-bit quad core processor clocking at 1.4GHz along with the support for powerful USB devices. Other improvements include the notching up Wi-Fi and Bluetooth modules to the current generation standards.

B. Ultrasonic sensors

These Sensors emit short, high-frequency sound pulses at regular intervals which propagate in the air at the velocity of sound. When they strike an object, they are reflected back as echo signals to the sensor, which using the written algorithm computes the distance to the target object as a function of time measuring the gap between emitting the signal and receiving the echo. It will send a positive signal when a person picks up the item from the designated shelf.

C. PIR sensor

The PIR module consists of a pyroelectric sensor which generates energy when exposed to heat, meaning when human or animal bodies get in the way of the sensor it'll detect the bodies as they emit heat in the form of Infrared radiation. The pyroelectric sensor is passive in nature. Apart from this, the sensor module also has frontal lens which helps in focusing the IR signals to the pyroelectric sensor. Also, the module's sensitivity and the delay time for keeping the signal high can also be modified according to needs, along with the trigger options (Repeatable and Non-Repeatable)

D. MQTT protocol

The protocol we use here in the project for efficient data transfer is MQTT which stands for Message Queuing Telemetry Transport. It is an extremely light weight protocol that distributes simple telemetry information across the resource constrained clients. Since it uses a publish and subscribe communication pattern, it has a wide variety of uses in modern technological fields such as machine-to-machine (M2M) communication and also plays a vital role in the Internet of Things environment. This wireless protocol is used for effective communication.

Abbreviations and Acronyms

- MQTT stands for MQ Telemetry Transport and PIR stands for a passive infrared sensor.

III. BACKGROUND LITERATURE

Smart Shopping is not a new concept. Amazon has previously shown off this concept with the Amazon Go platform and the accompanying app. Amazon Go is a revolutionary concept where the consumers get a Walk Out Shopping experience, they simply have to use the Amazon Go app, take the products they want from the store, and leave, as seen in the referred paper below [15]. No lines, no checkout. Quite similar to what the borrowed innovation here has to offer. This concept is not foreign to Chinese consumers as well. One of the several venture-backed start-ups is BingoBox, which is a cashier-free convenience store. It is very basic compared to Amazon Go. Though Amazon uses artificial intelligence and facial recognition to identify the buyer with the items and checkout altogether in virtual cart. At BingoBox, all items are labelled with RFID tags that scan the items at self-checkout machines as mentioned in the references mentioned below [3],[5] and [7]. This field has already been explored and the concept of automating buying/selling goods is not new. The most basic form can be observed in Japan in the form of Vending Machines.
As a whole, the rapid emergence of related technologies minimizing the role of human labour has brought all the tech wiz industries to jump to a solution, much faster than the state counterparts.

The implementation adopted in this project is fairly simple. Each commodity in the Mall will be placed in the designated aisle, which will contain a system of Ultrasonic and PIR sensor working together to detect person picking the item from the shelf. Also, each shopping trolley is proposed to be attached with RFID tag. A centralized system will be implied to help with queries concerning the billing transaction of the products by the customers. Even the exit gates of the mall will be laced up with the RFID readers for detecting any theft. There is no need for a person to be present at the billing counter. The process of buying items from the mall follow the below mentioned chronological steps: (1) The user walks in the store, connects his mobile to the Store WIFI and open the customer app. (2) In the app, the user will be presented with the information of every item he passes by walking through the aisles of the store, which he can later choose to pick or leave. This way we can save paper by avoiding the printing of the discount and price tags for each product in the aisle. They can now be simply updated in the Centralized server ready to be displayed to the users that walk by it. (3) After the user has put the items in the trolley, he/she can now simply proceed to the checkout button in the app. Doing so he will be presented with the final bill. This amount can be paid after the user walks out of the store through the exit gate rigged with the RFID tags which will communicate with the trolley and determine if the number of items in the trolley are equal to the items checked out in the app. This is the final verification step. The time spent at the queues for the bill payment in the shopping complexes can thus be cut off by the self-scanning methodology.

IV. SYSTEM ARCHITECTURE

The figure below (Figure 1) represents the architecture of the project:

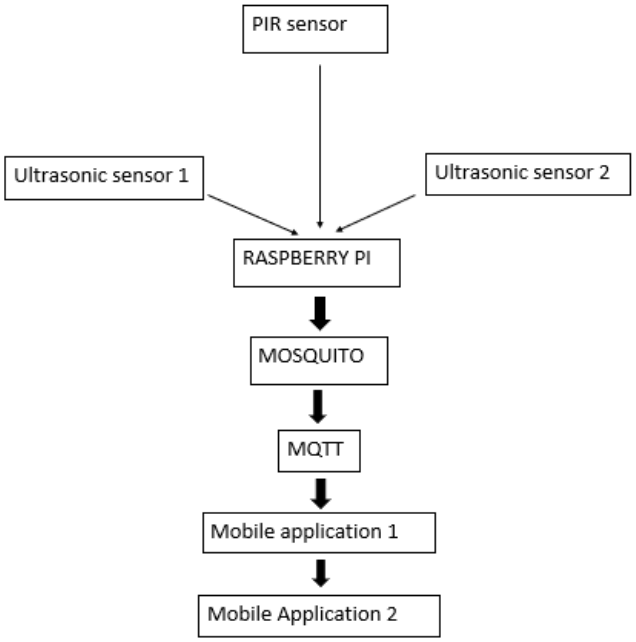


Fig. 1 Block Diagram for the architecture

In this system architecture, we can see that the three sensors when triggered, sends the corresponding product's details to the Raspberry Pi, which at last reaches the customer who has triggered the sensor, via a communication protocol – MQTT protocol. The customer can specify the quantity of purchased product and can finally head to check-out and pay the bill.

V. ALGORITHM

Design Considerations:

● The mobile application is made on Android Studios and the data of the products is stored in JSON format.

● The main purpose of the Raspberry Pi is to simplify the communication process as it comes with an in-built Wi-Fi module.

● Display of product details on the mobile application of the customer and on billing, the details of the cart are displayed on the cashier-end of the app.

Description of the Proposed Algorithm:

The main algorithm and idea of the project revolves around MQTT protocol. This protocol, uses publish and subscribe method, where in, clients are subscribed to a topic generated by a central broker, which is the Mosquitto Broker in this project. A publisher can post the message on the particular topic and those clients subscribed receive the message. In this project we use the same system. The customers phone application is automatically subscribed to the topic of the aisle in the shop. Once the customer walks by a product, the Raspberry Pi, which hosts broker, sends message to the customer about the product details. Similarly, when the customer has finished shopping and has hit the Bill button on the app, the corresponding customers shopping cart is sent to the multiple cashiers subscribed to the topic "Bill" and the vacant cashier attends the customer to finish with the billing.

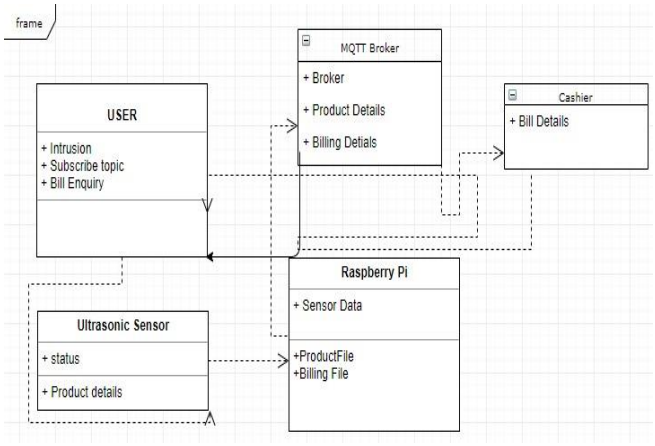


Fig 3. Class Diagram

VI. IMPLEMENTATION

The smart shopping system consists of sensors that detect human movement. As soon as the customer walks by a product, the sensor is triggered and the corresponding product details are displayed on the customers phone via the application. Whilst dropping the product to their trolley, they must also add the product to their cart on the app along with its quantity. All the information regarding the product associated with it is stored and sent to the mobile application using MQTT protocol. All the activities are coordinated together using a Raspberry Pi controller. When the customer wishes to leave, they can hit bill on their application, which sends the entire bill of the customer to the cashier. The cashier then checks for validation purposes and the customer can make the payment as convenient. The application is dynamically updated as and when the customer places the bought commodities into the cart. The customer can pay the bill online or through mobile wallet. After the payment of the bill, the database is updated and the user can leave the store.

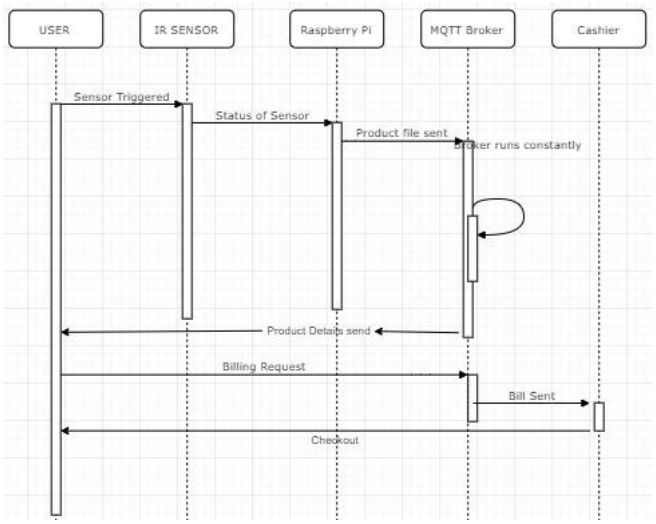


Fig 2. Sequence State Diagram

VII. RESULT

The smart cart is developed successfully with all the above-mentioned features and it can be put into use. Amazon Go has recently launched its smart shopping which is similar to this system but with the absence of the mobile application. The mobile application designed is very user friendly and can be used to see the map of the shopping mall as well. With the help of this shopping system, overall printing of papers and brochures listing product details, and paper bills will substantially reduce. It would also help in reducing the time spent on long queues for the billing process. The system developed is feasible and can be easily fit into the cart due to its size. the hardware setup is as shown in the figures below.

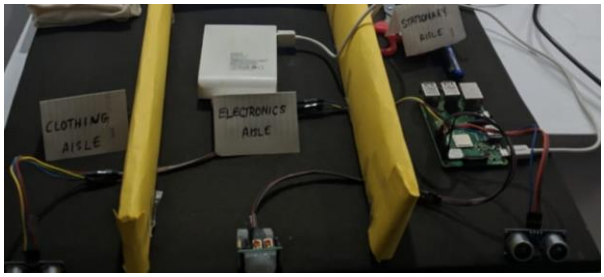
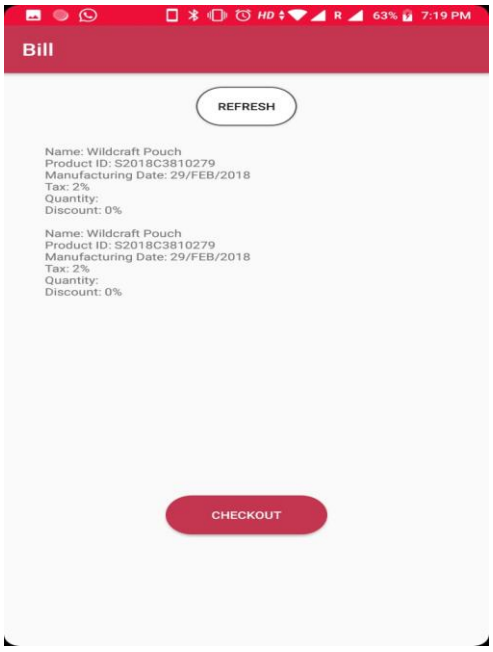


Fig 4. Physical components

Fig 5. Working model



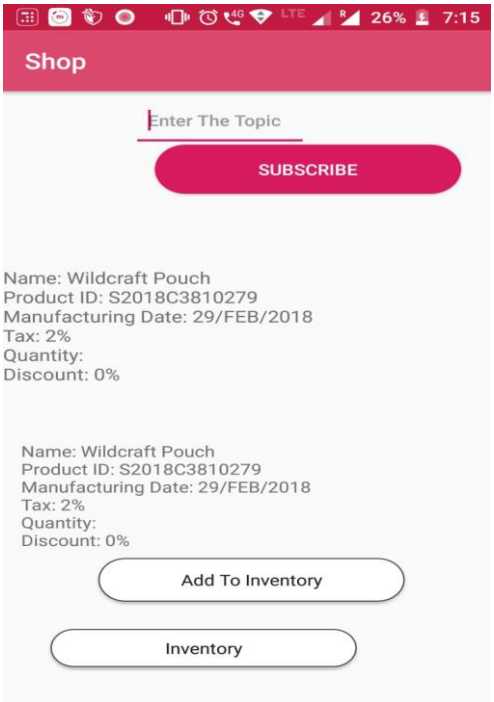


Fig 6 and 7. Screenshots of the mobile application

VIII. CONCLUSION AND FUTURE WORK

This prototype involves in providing the customers with a new and easy shopping experience. New technologies are implemented to provide the lowest delay time and smarter solutions. Our hypothesis was to design a user friendly shopping cart that would enhance the shopping experience. The customer doesn't have to wait till the checkout or use their calculators or prick their heads to know how much the shopping cost has come up to and to see if they got it within their money constraints using the alert. Also for a person who is unable to read or find the product price printed on the product while purchasing doesn't have to seek the help of anyone to know it. They just have to scan the product and the product details are displayed. This shopping cart is user-friendly, reliable and very convenient for the customer.

This project can be worked upon further by adding various features and amenities to the shopping experience. A manager-end of the application can be made which interprets certain details such as, what product was picked up from which aisle, which product is selling more and which isn't and so on, to the shop's manager. This would help the shopkeeper boost their profits. The prototype could also be easily scaled to larger shops with a central hub monitoring the sub branches of each aisle.

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