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IoT Based Indoor Navigation and Automated Stock Management in Smart Marts

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ABSTRACT
In this present world, with everything being automated individuals choose smart devices and digital data for daily use. Due to the size and complexity of large indoor spaces like huge supermarkets, people need guidance to find way to their destination. In this research, we have created an android mobile application based on QR (Quick Response) code scanner technology to help individuals to navigate in indoor spaces. Our objective is to minimize shopping time and traditional ask and find method by providing indoor navigation system for people who are unfamiliar with the area. We have utilized IoT (Internet of Things) technology in the automated stock management system because of its usage in real time applications in management, reliability and security in data usage. Using load cell sensor, the weight of the product will be measured and updated dynamically in the app. So, the customer and manager will be able to know the quantity of each product along with the navigation.

KEYWORDS
Indoor navigation, Firebase, Load cell Sensor, fcm (Firebase Cloud Messaging), QR code technology, Android based Smart Phone.

1. INTRODUCTION

The use of indoor navigation systems is growing as a result of advancements in mobile computing and internet-based communication. Greater public use of geographical information creates new applications which increases the need for indoor representations and the tools needed to use them [1],[21]. Indoor navigation devices are meant to assist clients, as people tend to forget their direction more easily within buildings than outside. By providing reference points and other information, the conceptual work associated with route planning, orientation, and monitoring is also reduced [2],[23],[24].

After analyzing the current apps and taking into account the issues in the indoor space, it has been determined that the following improvements are necessary for these apps: Presenting more data that is tailored to the area in order to assist within an environment and creating a system that functions in every real-world setting [3],[20]. This study suggested the indoor navigation system to help users find their way precisely inside buildings in order to address the aforementioned problem. A guided route to the user's chosen destination is displayed as the user's position is continuously tracked by navstore app which we created [4],[25].

In this indoor navigation application, instant dynamic updates about product quantity and details are provided which reflect changes in product quantity as soon as they occur, ensuring real-time accuracy [5],[19]. It is a convenient feature in stock management scenarios, e-commerce using IoT which is user friendly and interactive.

The IoT device that sends updates to the android application comprises of a load cell, where we place each load cell below a container which measures the quantity by calibration [6],[13]. This load cell is interfaced with ESP32 (Espressif Systems Processor 32) microcontroller which is a wireless Bluetooth and Wi-Fi module for measuring voltage levels and built in ADC (Analog to Digital Converter) to convert analog signal from the load cell to a digital value.

This device also notifies the user when product quantities fall below the predefined thresholds to indicate low level or unavailability of stock [7],[14]. The managers are alerted through a text message to prompt restocking actions.

To store and manage databases we have used google firebase as our data base management system to keep track of all the necessary information like indoor map locations or routes and product data related to it for offline navigation in case of limited connectivity.

The remaining sections of the paper are structured as follows: In section II, Literature review about existing approaches is discussed. Flow charts are discussed in system model of section III. In section IV, problem methodology was explained and their systematic approach. In Section V, it shows us the results and discussions based on obtained outputs and followed by conclusion.

2. REVIEW OF EXISTING LITERATURE

The methods and techniques developed in various literature surveys are discussed below. According to Smart Grocery Management System Using IoT, the system helps the user purchase wisely for groceries [8]. The ultrasonic sensor in this system is used to measure the level. In order to gauge the humidity inside the container, it also incorporates a temperature sensor. The development of an application to place orders for groceries automatically is the next task.

A system where the kitchen cabinet is equipped with a sensor to measure the weight of products in jars that are marked with RFID tags for location identification is proposed by the Design of Smart Kitchen Management System using IoT [9],[17]. Depending on how the product is used, an automated shopping list is created. The notion for RFID (Radio Frequency Identification) tag identification without additional hardware is implemented through the analysis of a UHF (Ultra High Frequency) RFID system for interior position sensing [18].

A brief overview of the available interior navigation tools showed that, for the purpose of this discussion, every one of them is not ideal. The indoor navigation using QR codes these are not used only for positioning, but also for escorting users along the route [10]. Therefore, the premise of this study on indoor navigation is that users can orient themselves enough if initial location is only gained through reference points. By means of scrutinising the outcomes acquired from user-completed navigation tasks, we acquired information pertaining to the elements that are frequently referenced [11]. The findings demonstrate that individuals orient themselves differently within the same environment and utilise the environment's structural aspects as their primary points of reference.

Table. 1 Comparative Study Table

Other Research Papers	Our Research Paper
Only shows navigation in indoor spaces.	Shows navigation in indoor spaces along with the weight of the product of each one.
They used Wi-Fi beacons technology which is expensive.	We used QR code scanner technology which is less expensive.
They have used FSR sensor which does not give weight accurately.	We have used Loadcell sensor which gives accurate weight of the product.
No alert message to the manager is shown when the quantity goes below the threshold level.	Alert message is sent to the manager when the quantity goes below the threshold level. Such that the manager will refill the stock.

3. SYSTEM MODEL

In this indoor navigation and automated stock management system admin app and navstore app was developed. In this system there are several objects that play a key role to manage the product data and navigate towards the destinated products.

Admin app contains the data of all the products and history of the orders placed. This data is stored in the firebase and can retrieve the data at any moment if in case of loss of data. It also alerts the manager by a text message when the quantity goes down by the limit using firebase cloud messaging system. So that the manager will be alert and refill the stock. Fig. 1 shows the flowchart for admin app.

We have developed Navstore app where customers can find their way to reach their destined products effortlessly. As in Fig. 2 it represents the flowchart for navstore app and through QR code technology we can navigate our desired product in supermart. We can place order in terms of units of grams where this data dynamically updated to the navstore app. This data is also reflected in the admin app where the manager can be able to see the quantity of each product available. We have loaded the static maps for each node-to-node reference points and gave these images as an input to the user.

Fig. 1 Flowchart for manager login

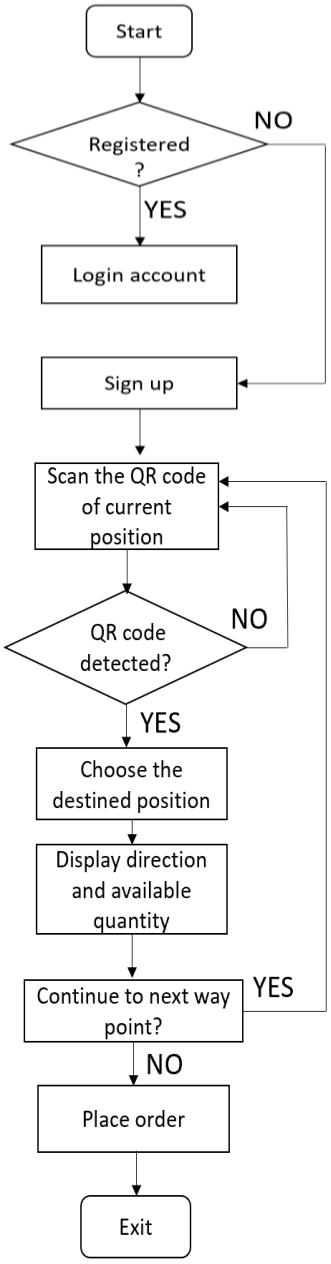

Fig. 2 Flowchart for customer login

Fig. 3 represents the architecture for automated stock management system. In this system we use load cell sensor which weighs the product by amplifying the analog signal to digital signal using HX711 amplifier.

This system gives us the weight of the products by placing the load cell sensor beneath the product containers, the force or pressure applied on it gives us the voltage fluctuations. Due to this this voltage fluctuations the amplifier helps us to amplify the analog signal to digital signal where we can display the value in units. We have also kept an alert if the quantity goes down the threshold value. We also notify the users or customers if the product is out of stock by displaying the number of quantity available in the indoor navigation application [12],[22].

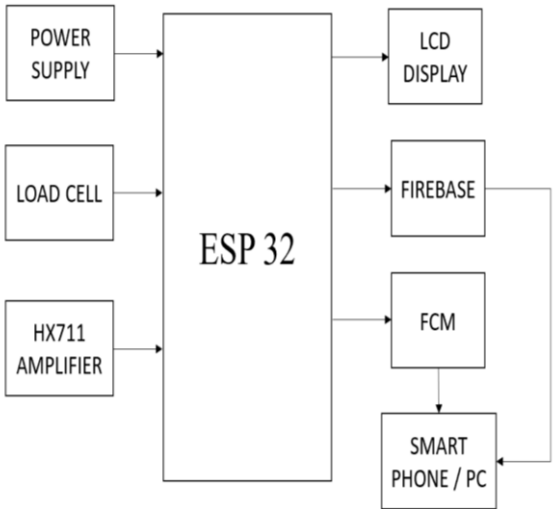

Fig. 3 Architecture for stock management

4. METHODOLOGY

Our project methodology is based on development of indoor navigation android app and also encompasses with the IOT device for data base stock management system. In Fig. 4 it describes about the architecture of our project. We have divided the application into two, which are Navstore app & Admin app. In Navstore app we have customer login and we have to scan our current location and it asks for the destinated product you want to reach. Now choose the product that you want which provides direction to your destined product.

We have used QR code labels placed at every point of location, the user should select the scan option to identify their current location by scanning the QR code label placed on the nearest product [9]. It then asks what is your destined product location, choose your desired location and it will show you the static map present in it. These static maps are designed manually and loaded the map in from and to user locations. This application only works on android based smart phones.

Reference points are noticeable components of the surroundings that help individuals find their location and identify the spatial links between paths and things. Here we are using QR code labels at particular reference points in real environments to help people comprehend the purposes and locations of landmarks [4]. For example, every section in the super market such as dairy products, cleaning, vegetables, a stairway can be used as structural reference points. These are highly usable and have a vivid location in the environment.

In this system, online indoor floor plans or maps can be obtained in advance to provide spatial reference [5]. Initial location and destination come from users input displaying the enroute location to the customer connecting the location corresponding to the scanned QR label and the selected destination from the dropdown list in the application [6].

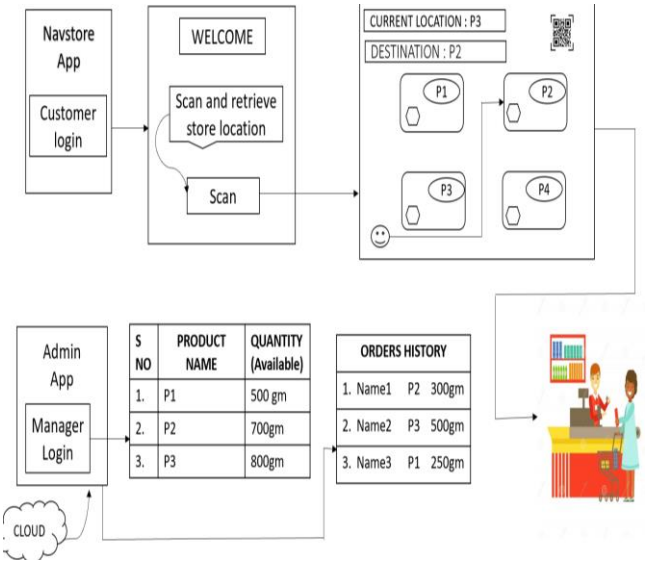

Fig. 4 APP design Overview

It also displays product information while navigating, like how much quantity is present and is the stock available or not. In Admin app we have manager login section, the manager will be able to see the product details and also about orders history of the customers. The manager will get a text message through fcm which is used to get push notifications when the product quantity goes down by the threshold value.

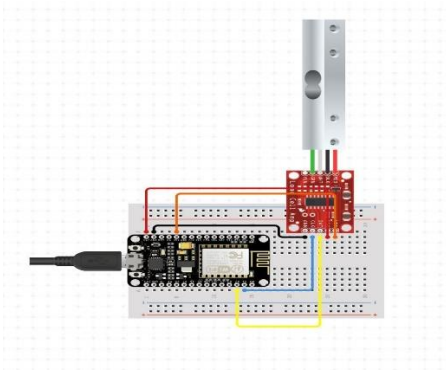

Fig. 5 Hardware circuit connections

In Fig. 5 this describes about the connections for stock management to weigh the product using load cell. The load cell we have used has the capacity up to 10kgs to bear the weight of the product [10],[15]. The ESP 32 comes with GSM connectivity which is used to build communication between mobile devices. The load cell amplifies the signal from analog to digital using HX711 amplifier [11],[16]. The HX711 amplifier uses a two-wire serial protocol to communicate with the esp32 microcontroller.

In this system the output is shown on serial monitor which displays the weight of each product when we placed and this data will be stored in firebase. We have now interfaced this data with the application which we have deployed for indoor navigation in order to represent the data in it [12]. We have used Arduino platform to code by using C++ language and using java language we have deployed navstore and admin app through API.

5. RESULTS AND DISCUSSIONS

In Fig. 6 we have to enter in the serial monitor which type of product you want measure the weight or know about the quantity.

To get accurate results we have calibrated ESP32 with loadcell.

Calibration factor = (reading / known weight)

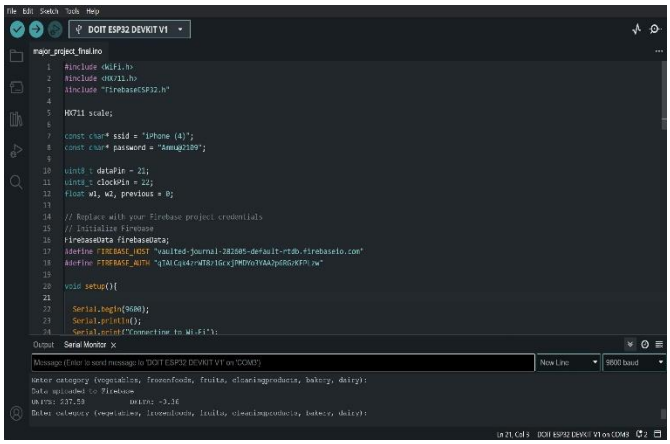

Fig. 6 Code for measuring the product

In Fig. 7, we have placed tomatoes under vegetable section as a prototype on the load cell, loadcell converts the force applied on it in to digital values and we can be able to see the quantity present in our navstore app and admin app.

Time to time when the quantity of the product changes it automatically updates in the firebase system which reflects in the navstore and admin apps.

Fig. 7 Prototype testing -1

Similarly, another product is placed under dairy section as shown in Fig. 8 whose weight is measured by load cell and amplified by the HX711 sensor connected to load cell to amplify and condition the signal received from it and interacts with esp32 micro controller that further pushes those weight values to the firebase cloud. It also updates the value if the quantity is removed or added dynamically after some time. We have created a grocery mart which has QR codes, where we can scan our current location through it as shown in the Fig 9.

Fig. 8 Prototype testing - 2

From Fig. 10 to Fig. 15, these are the outputs of navstore app and admin app. In Fig. 10 we can see that first step is by signup or through login. Fig. 11 shows the scan option where we can know our current location by scanning it and next choose the destinated product you want to reach in the store. Now you will be getting a static map where you can know about the quantity of respective products and we can choose how much quantity is to be placed as shown in Fig. 12.

Fig. 9 Grocery mart

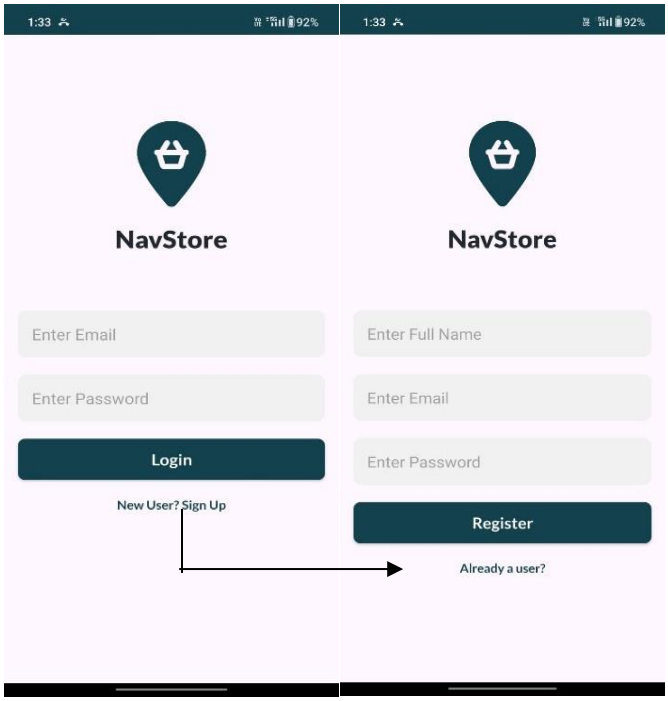

Fig. 10 Customer login

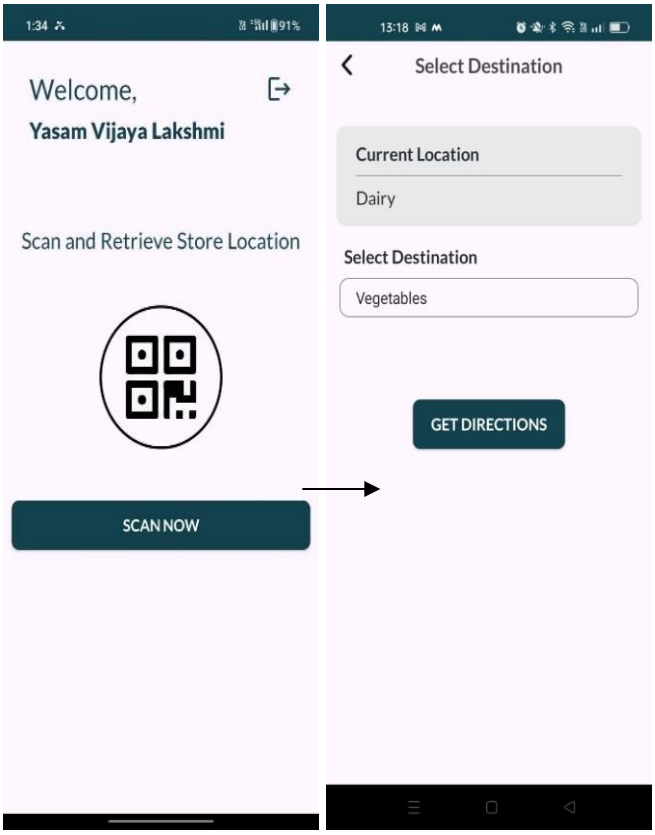

Fig. 11 Scan and choose your destined product

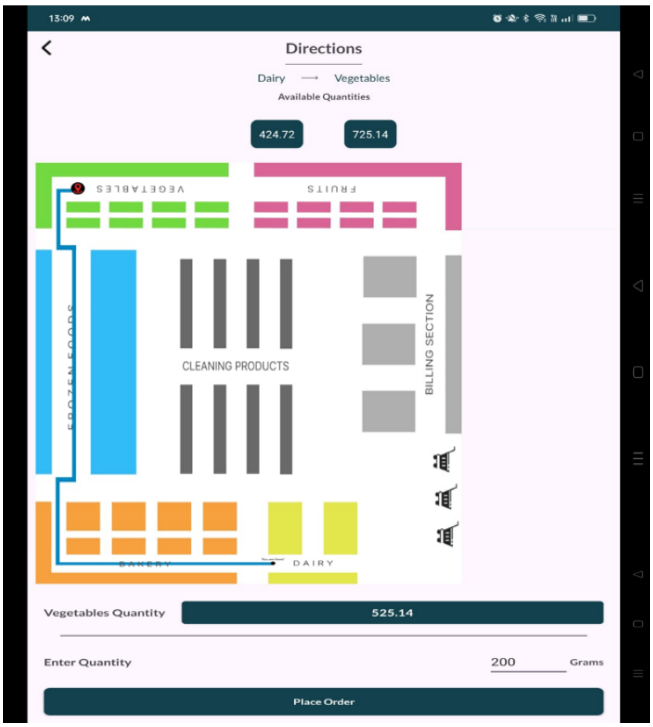

Fig. 12 Results obtained during prototype testing

In Admin app manager will be logged through it as shown in Fig. 14 and after login he/she will be able to see the stock available in the navstore app or in supermart. He / She can also know about orders history if placed any by the customers in detailed for example customer name, the product they placed and how much quantity as shown in Fig. 15. The manager will also get alert in the admin app through a text message with the help of fcm. Here we have kept the limit value of 100grams. So, if the quantity goes down by the limit the manager will get a text message to refill the stock. We can see it in Fig. 13.

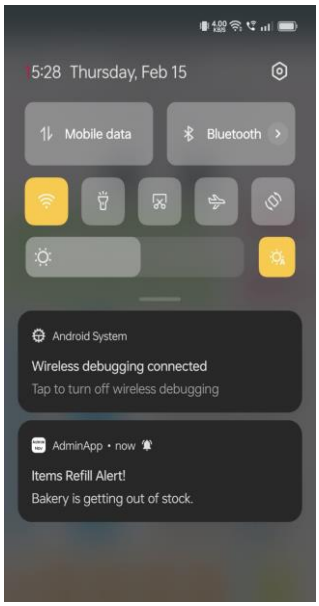

Fig. 13 Alert message to the manager

Admin app outputs:

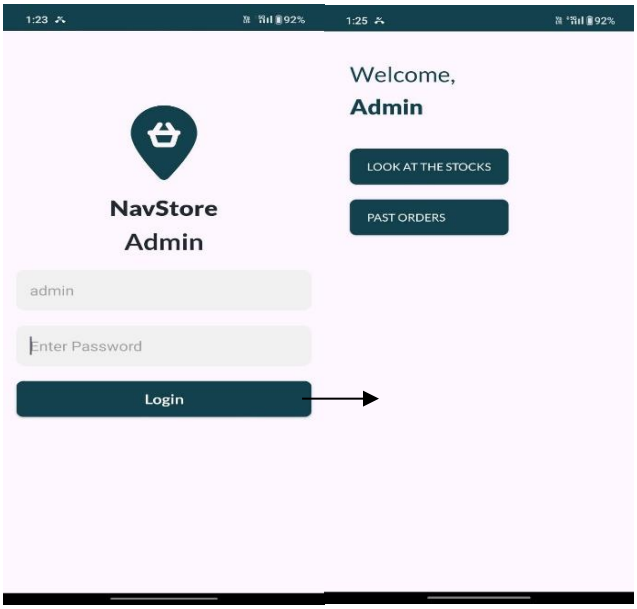

Fig. 14 Admin login

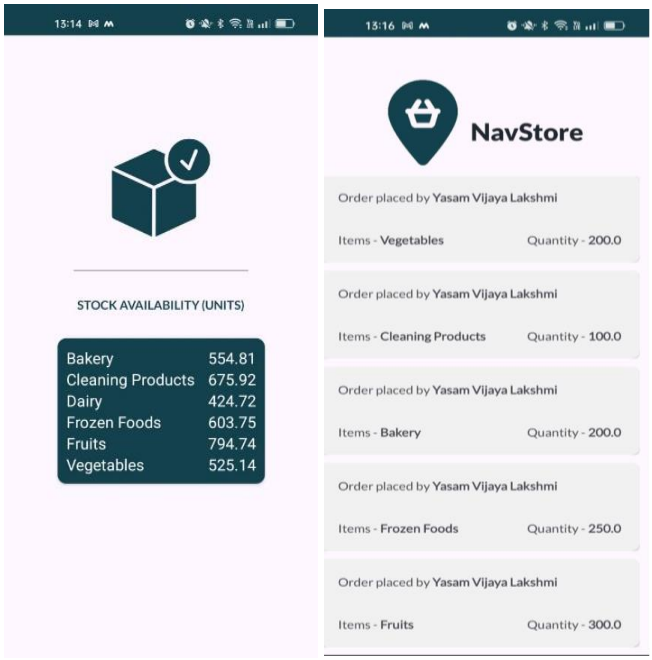

Fig. 15 Stock Availability & Orders History

6. CONCLUSION

In conclusion, the indoor navigation and automated stock management system using IoT has successfully demonstrated integration of modern technology to enhance efficiency and convenience of managing product supplies. Through implementation of connected sensors, microcontrollers and cloud-based platform, we achieved real-time monitoring and stock management.

QR code-based navigation offers a contactless solution where customers can easily identify the products in an unknown supermart through navstore app which also provides the information related to the product quantity along with the directions. Also, manager can easily able to know when the product is out of stock through admin app and they refill the stock immediately. Future scope of smart indoor navigation is we can deploy this indoor navigation using dynamic approach to acquire real time location for customers. The novelty of this project can be integrated with Augmented reality (AR) into these systems. We can also place temperature sensor inside the container to measure the humidity of it, such that we can know about the product quality.

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