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A Project Work Phase-1 Report

on

"Smart Shelves in a Retail Store"

Submitted in the partial fulfillment for the award of

BACHELOR OF ENGINEERING

in

INFORMATION SCIENCE AND ENGINEERING

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BMS INSTITUTE OF TECHNOLOGY & MANAGEMENT

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CERTIFICATE

This is to certify that the Project work Phase-1(18CSP77) entitled **"Smart Shelve in a Retail Store"** is a bonafide work carried out by **Mr Pratikansh Srivastava - 1BY19IS120, Mr. Mishal Sourav - 1BY19IS096, Mr. Rauneet Verma - 1BY19IS132, Mr. Sumit Verma - 1BY19IS195** in partial fulfillment for the award of **Bachelor of Engineering Degree in Information Science and Engineering** of the Visvesvaraya Technological University, Belagavi during the year 2022-23. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in this report. The project report has been approved as it satisfies the academic requirements with respect to project work for the B.E Degree.

Signature of the Guide Dr. Shoba M	**Signature of the Coordinator** Dr. Rakesh N
Signature of the HOD	**Signature of the Principal** Dr. Mohan Babu G N

ABSTRACT

Smart shelves, the electronically connected shelves which can automatically monitor the shelf of the inventory in a retail establishment is one of the most feasible solutions to address the ‘out of stock’ items in physical stores A smart shelf is a shelf in a store that has been equipped with the ultrasonic sensors, a device that can measure the distance between the shelf and the product by using sound waves and the level of stock can be viewed in retailer application.

A microprocessor is installed on the shelf for data processing Android applications for supplier and retailer are developed. Using this android application notifications are sent or received from microcontroller. Automatic replenishment alert is one of the most potential uses of smart shelves in the retail business area. The smart shelf notices when it's running out of an item and sends an alert to the back-end system. Depending on the system application of the store, the alert is either sent to the backroom or to a mobile computer, so that sales personnel can replenish the shelf or make order for more items.

The growth in digital technology has given most sectors an economic boost, especially retail. Digital technology has successfully made a new concept of an online store and brick-and-mortar presence. However, a physical store is still in demand for most individuals, considering the convenience of grab and go without waiting for delivery. Some recent studies found that most retailers face the same issue with the customers who tend to be more demanding towards selecting a product with specific brands. Therefore, the retail sector, which could provide more products, brands, and freshness, will win, whereby small retailers could only depend on pricing to beat the competitor.

ACKNOWLEDGEMENT

We are happy to write a project report after completing it successfully. This project would not have been possible without the guidance, assistance and suggestions of many individuals. We would like to express our deep sense of gratitude to each and every one who has helped us to make this project a success.

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We gratefully thank our project guide**, Dr. Shoba M, Associate Professor Dept. of Information Science and Engineering,** for his/her encouragement and advice throughout the course of the project work.

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Special thanks to all the staff members of the Information Science and Engineering Department for their help and kind co-operation.

Lastly, we thank our parents and friends for their encouragement and support given to us in order to finish this project work.

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Declaration

We, hereby declare that the project phase-1(18CSP77) titled "SMART SHELVES IN A RETAIL STORE" is a record of original project phase-1 work undertaken for partial fulfilment of Bachelor of Engineering in Information Science and Engineering of the Visvesvaraya Technological University, Belagavi during the year 2022-23.We have completed this project phase-1 work under the guidance of **Dr. Shoba M. Associate Professor**.

I also declare that this project phase-1 report has not been submitted for the award of any degree, diploma, associate ship, fellowship or other titles anywhere else.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

In the past few years, product recognition applications have gained increasing interest in computer vision. Retail product classification system can be used for assisted shopping by the customers, tracking of the consumer product arrangements on the shelves, and real-time management of inventory distortions such as out-of-stock and overstock. Fine–grained classification is one of the challenging problems in computer vision. In retail stores, there are a large number of fine-grained product classes and many products have similar appearance in terms of shape, color, texture and metric size. Besides, the product images are captured under real world conditions. So, the captured images are very. This work was partially supported by the Scientific and Technological Research Council of Turkey through a graduate student fellowship. Likely to suffer from many problems such as different viewing angles, blurriness, occlusions, unexpected background parts, and very different lighting conditions. Such complications in the images make the retail product recognition problem more challenging. Accordingly, an effective product classification system needs further information in addition to knowledge obtained from the product image. In retail industry, a diagram, which is called as planogram, is used in order to maximize the potential of a store. A planogram shows how and where specific retail products should be placed on retail shelves. The products on shelves in a store are usually displayed in certain arrangements rather than randomly. Generally, in planograms, same or similar products are more likely to appear adjacent to each other. Thus, there is a spatial continuity and structure in placements of the products on the shelves in terms of both brand and metric size.

1.2 Motivation

The growth in digital technology has given most sectors an economic boost, especially retail. Digital technology has successfully made a new concept of an online store and brick-and-mortar presence. However, a physical store is still in demand for most individuals, considering the convenience of grab and go without waiting for delivery. Some recent studies found that most retailers face the same issue with the customers who tend to be more demanding towards selecting aproduct with specific brands. Therefore, the retail sector, which could provide more products, brands, and freshness, will win, whereby small retailers could only depend on pricing to beat the competitor.

1.3 Problem Statement

Implementation of iBeacon based smart shelves for retail stores based on IoT devices. It mainly focuses on most retailers' current state and issues. It critically evaluates similar systems and justifies the use of IoT devices and other infrastructural components using a systematic approach, and finallyprepare the architecture and recommendations for building the iBeacon based smart shelves for retail stores.

1.4 Proposed System

The proposed iBeacon based Smart Shelves are integrated with IoT devices and mobile applications, which allow the retail staff and store manager to keep track of the inventory online. This system provides real-time data in terms of stock management and maintaining the required temperature on the shelf. Once the items are out of stock, the retail staff and store manager will receive a notification to replenish the items.

The objective of this task is to utilize computer vision method to perform object identification and improvise the algorithm specifically, we need a framework ready to perceive items on store racks. This challenging task is complicated for a machine learning algorithm, due to the high number of different conceivable variety in which the equivalent item can happen into the object detection. The straightforward arrangement proposed here gives the best in class identifiers dependent on deep learning and traditional methods for object detection.

1.5 Objectives

For retail staff:

- Able to receives an update regarding the items inside the shelf.
- Able to keep track of the current number of items.
- Able to check the shelf life to keep the items in good condition.

For store manager:

- Able to keep track of the current stock in the retail store.
- Able to monitor the favourite items of the month

CHAPTER 2

LITERATURE SURVEY

2.1 Critical Analysis of the Literature Survey

Architectural Design and Development Recommendations for iBeacon based Smart Shelves in a Retail Store (Published by IEEE in 2022)

The researchers have proposed the implementation of iBeacon based smart shelves for retail stores based on IoT devices. This research mainly focuses on most retailers' current state and issues. This research critically evaluates similar systems and justifies the use of IoT devices and other infrastructural components using a systematic approach, and finally proposes the architecture and recommendations for building the iBeacon based smart shelves for retail stores.

Design of Smart Unstaffed Retail Shop Based on IoT and Artifical Intelligence (Published by IEEE in 2020)

In the present study, a smart unstaffed retail shop scheme is proposed based on artificial intelligence and the internet of things, as an attempt to enhance the user shopping experience remarkably. To analyze multiple target features of commodities, the SSD (300 × 300) algorithm is employed; the recognition accuracy is further enhanced by adding sub-prediction structure. Using the data set of 18, 000 images in different practical scenarios containing 20 different type of stock keeping units, the comparison experimental results reveal that the proposed SSD (300 × 300) model outperforms thanthe original SSD (300 × 300) in goods detection, the mean average precision of the developed methodreaches 96.1% on the test dataset, revealing that the system can make up for the deficiency of conventional unmanned container. The practical test shows that the system can meet the requirements of new retail, which greatly increases the customer flow and transaction volume.

A Bluetooth Location-based Indoor Positioning System for Asset Tracking in Warehouse
(Published by IEEE in 2021)

Industrial application of low-cost Bluetooth location-based indoor positioning system in asset localization. In this paper, a Bluetooth location-based indoor positioning system is proposed for warehouse asset tracking purpose to achieve a cost-effective asset management solution. . Finally, an implementation of the experiment in a shopping mall is conducted to practically examine performanceevaluation of the location-based scheme. The experimental results show that the proposed scheme could achieve significant higher precision than other localization techniques.

A Location-Based Smart Shopping System with IoT Technology
(Published by IEEE in 2019)

Researchers design a smart shopping platform including four components, location of everything component, data collection component, data filtering/analyzing component and data mining component. Then a novel accurate localization scheme named "location orbital" is developed that estimates the current location of mobile objects (users or everything) based on both current and the previous locations. Finally, an implementation of the experiment in a shopping mall is conducted to practically examine performance evaluation of the location-based scheme. The experimental results show that the proposed scheme could achieve significant higher precision than other localization techniques.

A survey of Internet of Things: Future Vision, Architecture, Challenges and Services
(Published by IEEE in 2020)

This paper presents a novel architecture model for IoT with the help of Semantic Fusion Model (SFM). This architecture introduces the use of Smart Semantic framework to encapsulate the processed information from sensor networks. The smart embedded system is having semantic logic and semantic value based Information to make the system an intelligent system. This paper presents a discussion on Internet oriented applications, services, visual aspect and challenges for Internet of things using RFID, 6lowpan and sensor networks.

Smart Shelf Using Internet of Things (Published by IEEE in 2020)

A smart shelf is a shelf in a store that has been equipped with the ultrasonic sensors, a device that can measure the distance between the shelf and the product by using sound waves and the level of stock can be viewed in retailer application. A microprocessor is installed on the shelf for data processing Android applications for supplier and retailer are developed. Using this android application notifications are sent or received from microcontroller. Automatic replenishment alert is one of the most potential uses of smart shelves in the retail business area. The smart shelf notices when it's running out of an item and sends an alert to the back-end system. Depending on the system application of the store, the alert is either sent to the backroom or to a mobile computer, so that sales personnel can replenish the shelf or make order for more items.

Context-Aware Computing, Learning, and Big Data in Internet of Things: A Survey (Published by IEEE in 2021)

One of the major problems in the path to intelligent IoT is understanding "context," or making sense of the environment, situation, or status using data from sensors, and then acting accordingly in autonomous ways. This is called "context-aware computing," and it now requires both sensing and, increasingly, learning, as IoT systems get more data and better learning from this big data. In this survey, we review the field, first, from a historical perspective, covering ubiquitous and pervasive computing, ambient intelligence, and wireless sensor networks, and then, move to context-aware computing studies. Finally, we review learning and big data studies related to IoT. We also identify the open issues and provide an insight for future study areas for IoT researchers.

Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications, Protocols,and Applications (Published by IEEE in 2018)

This paper starts by providing a horizontal overview of the IoT. Then, we give an dover view of some technical details that pertain to the IoT enabling technologies, protocols, and applications. Compared to other survey papers in the field, our objective is to provide a more thorough summary of the most relevant protocols and application issues to enable researchers

and application developers to get up to speed quickly on how the different protocols fit together to deliver desired functionalities without having to go through RFCs and the standards specifications. We also provide an overview of some of the key IoT challenges presented in the recent literature and provide a summary of related research work. Moreover, we explore the relation between the IoT and other emerging technologies including big data analytics and cloud and fog computing. We also present the need for better horizontal integration among IoT services. Finally, we present detailed service use-cases to illustrate how the different protocols presented in the paper fit together to deliver desired IoT services.

DiffNet: A Learning to Compare Deep Network for Product Recognition (Published by IEEE in 2019)

The paper focuses on the identification of different objects in a pair of images taken from the same environment, which is challenging and has wide application. We propose a single deep convolutional neural network termed as DiffNet to solve this problem. DiffNet takes a pair of images as the input and directly regresses the bounding boxes of different objects. To train DiffNet, we only need to label the different objects, rather than all objects in input images, which significantly reduces human labeling efforts. Experiments are performed on an image dataset collected from unmanned containers.DiffNet obtains a very high product detection accuracy of 95.56% mAP at the speed of 143 fps measured on an NVIDIA TITAN Xp GPU.

Big Data Analysis-based Secure Cluster Management for Optimized Control Plane in Software- Defined Networks (Published by IEEE in 2020)

This paper proposes a big data analysis-based secure cluster management architecture for the optimized control plane. A security authentication scheme is proposed for cluster management. Moreover, we propose an ant colony optimization approach that enables big data analysis scheme and the implementation system that optimizes the control plane. Simulations and comparisons show the feasibility and efficiency of the proposed scheme. The proposed scheme is significant in improving the security and efficiency SDN control plane.

Knowledge Tradable in Edge-AI Enabled IoT: A Consortium Blockchain Based Efficient and Incentive Approach (Published by IEEE in 2019)

In this paper, we propose a peer-to-peer (P2P) knowledge market to make knowledge tradable in edge-AI enabled IoT. We first propose an implementation architecture of the knowledge market. Moreover, we develop a knowledge consortium blockchain for secure and efficient knowledge management and trading for the market, which includes a new cryptographic currency knowledge coin, smart contracts, and a new consensus mechanism proof of trading. Besides, a noncooperative game based knowledge pricing strategy with incentives for the market is also proposed. The security analysis and performance simulation show the security and efficiency of our knowledge market and incentive effects of knowledge pricing strategy. To the best of our knowledge, it is the first time to propose an efficient and incentive P2P knowledge market in edge-AI enabled IoT.

Smart Shelfve – Internet of Shelves (Published by IEEE in 2021)

We have enabled shelves to take its own selfie using a simple camera and then the image processing algorithms take over to do required analytics and raise alerts with the right person. This solution scores higher over other hardware and capital intensive IoT solutions being worked upon. The paper describes in detail about the work done by our team and the impressive results achieved. The solution can be implemented using a commonly available device like a smartphone camera or even the camera in retail shops can be put to use for real time or more frequent checks

Intelligent-loT Based Digital Racking System for Retail Shops
(Published by IEEE in 2020)

The objective of this paper is to utilize computer vision procedures and IoT in racking system to perform object detection. In the proposed IoT based smart shelf Intelligent IoT the changes about rackand products are distinguished in real-time utilizing OpenCV. This task is complex, because of the high number of possible variations in which similar scene of images can happen into the scene. The simple solution proposed here is both best in class locators dependent on deep learning and traditionalmethods for object detection. The IoT empowers connectivity of

physical object with the real-time communication by ESP8266 and data logged into cloud. The smart shelf rack and products details are logged into Database Management system are some desirable characteristics that result.

Context-aware hybrid classification system for fine-grained retail product recognition

(Published by IEEE in 2022)

The proposed hybrid approach improves the accuracy of context-free image classifiers such as Support Vector Machines (SVMs), by combining them with a probabilistic graphical model such as Hidden Markov Models (HMMs) or Conditional Random Fields (CRFs). The fundamental goal of this paper is using contextual relationships in retail shelves to improve the classification accuracy by executing a context-aware approach. The Implementation of the predicting the future supply and demands is done using time series analysis using several existing machine learning algorithms by utilizing historical data. In this research the prediction of future sales and demand in the supermarkets is done by considering the customers' behavior, the variety of product groups they buy and seasonal changes. These predictions are made on the assumption of a constant per capital supply of products and demand in our system

Smart Shelve Management System using IOT-A Novel Approach

(Published by IEEE in 2021)

The researchers developed a novel IOT based smart Infrastructure Management System which handles all the above problems. This system will save a not only save a lot of time of the user but also provide a smart way for placing an order. The Implementation of the predicting the future supply and demands is done using time series analysis using several existing machine learning algorithms by utilizing historical data. In this research the prediction of future sales and demand in the supermarkets is done by considering the customers' behavior, the variety of product groups they buy and seasonal changes. These predictions are made on the assumption of a constant per capital supply of products and demand in our system

Intelligent IoT Shelf Design and Development (Published by IEEE in 2022)

The purpose of this paper is to present the design and development of an intelligent shelf system, which is capable to measure the weight and can define the number of items placed on it. The hardwareand software components are presented detailed. The system uses load cells to measure the weight. The designed and developed electronic data acquisition module uses wireless communication to transmit the data received from the load cells. On the server side the data packets are received and processed by a custom UDP server and for data storage the system uses a MySQL database. A web application developed considering PHP language and Laravel framework is used to interact between the users and the database. The presented prototype system is a proof of concept solution for big stores with heavy traffic to follow and manage the number of products on stock in real time.

Vision Based Intelligent Shelf-Management System (Published by IEEE in 2020)

Machine learning processes are carried out for implementing the necessary functionalities and algorithms. Initially, the camera captures clear and real time images regularly. Then the system processes and detects the image similar to the threshold percentage or detect the empty shelves. Whenthe system detects the threshold percentage or empty shelves, the system will provide an alert to the labors. The Implementation of the predicting the future supply and demands is done using time series analysis using several existing machine learning algorithms by utilizing historical data. In this research the prediction of future sales and demand in the supermarkets is done by considering the customers' behavior, the variety of product groups they buy and seasonal changes. These predictions are made on the assumption of a constant per capital supply of products and demand in our system.

A Low Cost Approach to Large Smart Shelf Setups (Published by IEEE in 2021)

The system proposes an alternative to the approaches with multiple antennas placed in fixed position inside the shelf or around the shelves, offering a lower cost solution by means of dedicated electromechanical devices able to carry the antenna and the reader to the locations of interest along a rail system. Moreover, the antenna position can be controlled for three axis of movement allowing for extra flexibility and complete coverage of the shelves. The proposed setup is a fully wireless one. It contains a standard reader, electromechanical positioning actuators and
wireless communication and control hardware offering power from integrated batteries

Digitalization at the Point-of-Sale in Grocery Retail - State of the Art of Smart Shelf Technology and Application Scenarios (Published by IEEE in 2020)

Their respective application scenarios, the technologies behind them, the associated benefits and costsas well as planned further developments. Our results show that existing solutions cover a variety of application scenarios, ranging from out-of-shelf detection and checking planogram compliance to optimizing inventory or logistical processes. Our analysis identified two main technology groups: image recognition systems and sensor-based systems. Solution providers stated that generating a positive ROI takes between one and one and a half years. All providers are working on further developments, many are moving in the direction of sensor fusion.

Study of smart inventory management system based on the internet of things (Iot) Published by IEEE in 2022)

This paper presents a new type of intelligent Inventory Management System based on the IoT and explains the principles and structure of it. This system has great advantages compared to the traditional mode, and we expect good prospects for its development. Inventory Management is a key area for customer service and cost optimization in any manufacturing setup. As companies turn globaland have thousands of components and hundreds of warehouses the inventory becomes a nightmare and a lot of time is spend in tracking inventory and ensuring right shipments. Traditional systems of robotic arms for inventory pick and drop have been based on premises of marking areas of the warehouse and tracking it.

2.2 A Summary Table

S.No	Title	Author and Publication	Approach	Pros	Cons
1.	Architectural Design and Development Recommendat i ons for iBeaconbased Smart Shelves in a Retail Store	Muhammad Ehsan Rana Junie Halim Kamalanathan Shanmugam IEEE,2020	The researchers have proposed the implementation of iBeacon based smart shelves for retail stores based on IoT devices and other infrastructural components using a systematic approach.	iBeacon has a internal clock which can use to track of the expiry date	Need for automatic product recognition
2.	Design of Smart Unstaffed Retail Shop Based on IoTand Artifical Intelligence	Jianqiang Xu Junzhong zou IEEE,2021	To analyze multiple target features of commodities, the SSD (300 × 300) algorithm is employed.	Merger of IoT and AI successfully achieved	Need for better algorithm for recognition rate andefficiency
3.	A Bluetooth Location-basedIndoor Positioning System for Asset Trackingin Warehouse	C.K.M. Lee C. M. Ip IEEE,2021	Introduction of Kalman-LULU filter, in signal processing stage, helps increase the accuracy ofthe system and reduce noise in fast pace.	Kalman-LULU filter has better processing system than other filters available in the market	Need sensors for better evaluation of distance to achieve higher precision
4.	A Location-Based Smart Shopping System withIoT Technology	Javed Rezazadeh Kumbesan Sandrasegaran IEEE,2020	Based on four components include location of everything component, data collection component, data filtering/analysing component data mining component	GPS and IoT merger achieved	Need of more precisecomponent is needed

5.	A survey of Internet of Things: Future Vision, Architecture, Challenges and Services	Gaurav Tripathi Dhananjay Singh IEEE,2021	This architecture introduces the use of Smart Semantic framework to encapsulate the processed informationfrom sensor networks	Proper implementation ofSmart Semantic framework	The present architecture has the scope to improve a lot on the semantic and security front
6.	Smart Shelf Using Internet of Things	S.Subramanian V.Lalitha IEEE,2021	The system provides easy monitoring of stockinventory by using load sensors.	Implementation ofload sensors	Calibrating ultrason icsensors is expensive
7.	Context-Aware Computing, Learning, and Big Data in Internet of Things: A Survey	Ipek Baz Erdem Yoruk IEEE,2018	The researchers proposed a hybrid context-aware product recognition system thatclassifies products.	Merger of IoT andBig Data	Extend the model to 2D with spatial product configurations on shelves includi ng horizontal and vertical adjacencies.
8.	Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications	Ala Al-Fuqaha Mohsen Guizani IEEE,2019	The researchers presented the need for new “smart” autonomic management, data aggregation, and protocol adaptation services to achieve betterhorizontal integration among IoT service. Finally, detailed application-use cases were presented to illustrate typical protocolintegration scenarios to deliver desired IoT services.	Horizontal integrationof IoT devices	Better intergration of IoT devices will lead to better result

9.	DiffNet: A Learning to Compare Deep Network for Product Recognition	Bin Hu Qiang Zhou IEEE,2020	The researchers have proposed a system basedon the image set of 1846images	Big Dataset is used	Bigger dataset willproduce better result.
10.	Big Data Analysis-based Secure Cluster Management for Optimized Control Plane in Software-Defined Networks	Jun Wu Mianxiong Dong IEEE,2020	This paper proposed a big data analysis-based secure cluster management architecturefor optimized control plane. A secure authentication scheme was proposed to ensure the legality of the data sources.	Authentication isdone	A distributed security data storage scheme for the SDN controller cluster will be proposed
11.	Knowledge Tradable in Edge-AI Enabled IoT: A Consortium Blockchain Based Efficient and Incentive Approach	Xi Lin Jun Wu IEEE,2021	In this paper, to break islands of knowledge and make knowledge tradable in edge-AI enabled IoT, they proposed a P2P knowledge market for knowledge paid sharing.	Merger of IoT andBlockchain is achieved	Mass scale implementation has tobe achieved.
12.	Smart Shelfie – Internet of Shelves	Rakesh Satapathy Srikanth Prahlad IEEE,2018	Researchers have enabled shelves to take its own selfie using a simple camera and then the image processing algorithms take over to do required analytics andraise alerts with the rightperson	Automatic shelfies has been achieved forproduct recognition	Reduction of cost is to be made

13.	Intelligent-loT Based Digital Racking System For Retail Shops	Shiva M C Prakash Ramachandran IEEE,2020	Objective of detection,recognition and findinginstances of an information from a model has been achieved.	Single model for detection, recognitionis achieved	Implementation on large-scale is to be achieved
14.	Context-aware hybrid classification system for fine-grained retail product recognition	Ipek Baz Erdem Yoruk IEEE,2019	The fundamental goal ofthis paper is using contextual relationships in retail shelves to improve the classification accuracy by executing a context- aware approach.	Context-aware approach is achieved.	To extend our model to 2D with spatial product configurations on shelves includi ng horizontal and vertical adjacencies.
15.	Smart Shelve Management System using IOT-A Novel Approach	Nilesh Korde Abhijeet Thakare IEEE,2019	The system with the helpof weight and level sensor helps the user to identify required food items in a specific shelve(s) of a specific rack system	Level sensors is usedto keep track of the products	More precise sensors can be introduced for faster better results
16.	Intelligent IoT Shelf Design and Development	László Somai László Molnár IEEE,2018	Weight Sensors are usedto identify whether thereare products are in the shelf or not	Weight sensors is used to keep track ofthe products	Need to improve operational effiencies
17.	Vision Based Intelligent Shelf-Management System	Priyanwada H.A.M Nicoleta STROIA IEEE,2021	An original low cost system has been implemented as a solution for large setups of shelves on which items with RFID tags arestored	RFID tags gives morecoverage	Better precision can be achieved with the sensors

18.	A Low Cost Approach to Large Smart Shelf Setups	Florin Hrebenciuc Daniel Moga IEEE,2020	The proposed setup is a fully wireless one. It contains a standard reader, electromechanical positioning actuators andwireless communication and control hardware offering power from integrated batteries.	Low cost	RFID(Radio Frequency Identification) tags can be improved
19.	Digitalization at the Point-of-Sale in Grocery Retail - State of the Art of Smart Shelf Technology and Application Scenarios	Marike Kellermayr-Scheucher Laura Hörandner IEEE,2018	Use of two main technology: Image Recognition Systems Sensor Based Systems	IMR are used for product identification	There is also a need for research to shed more light on the user side. On the one hand, this involves retailers, their acceptance, barriers, needs and future plans.
20.	Study of smart inventory management system based on the internet of things (Iot)	Souvik Paul Atrayee Chatterjee IEEE,2019	This paper presents a new type of intelligent Inventory Management System based on the IoTand explains the principles and structure of it	Large Scale implementation isseen	It can be used in several areas in different applications and many enhancements can be done so that it can be made available to all the sectors.

2.3 Implication and Conclusion

The system provides easy monitoring of stock inventory by using load sensors, Arduino Uno, HC-SR04, Bluetooth and a mobile device application providing significant advantages like availability of real time sensor data on users mobile device, easy to use and set up application, implicit analysis of fetched data and generating alerts based on the same, prediction of data using machine learning etc. Although, this approach comes with a few disadvantages like overhead of calibrating ultrasonic sensors or expensive to scale up, the idea of sensing quantity of stock using load sensors and making it implicitly available to the users can be extensively use in manufacturing industry where stocks of raw material are tedious to monitor or if unexpected exhaustion of a particular raw material halts the manufacturing process. In this approach the devices are networked which is an attribute of poor level ubiquity. It can further be improved to be choreographed

2.4 Existing System

1) AWM Smart Shelf AWM Smart Shelf is focused on four different areas: automated inventory-leddisplay on a shelf, item mapper, and Content Management System. AWM solution is to improve theoffline retail store experience by developing an automatic shelf inventory level and giving the product description and pricing based on customer distance. AWM also analyses data that detect each customer's age, gender, and ethnicity automatically in the inventory system with items in the rack itself. It uses super-wide-angle low light HD cameras to give sight and virtual tracking for the products in a retail store. The result is shown in real-time as it frequently updates hourly updates or based on customer activity. LED display used in shelf to give detailed information about the products and available promotion. Its ability to distract customer attention often makes customers more interested in the products as the information displayed can be clicked and act as a button. Mapping for the product is another feature provided by AWM, where it gives a visual display of the products displayed in the retail store. It provides real-time insight into the already out-of-stock product and notifies to replenish the items. In addition, it helps to detect and specify which shelves need to be re-stock and increase customer satisfaction because they can allocate the product that customers look for by using their smartphone. The content management system, known as CSM, is used for inventory management that includes the prices and content. It is designed to be accessed from everywhere. The last feature is a data engine that analyses customer behavior in real-time and gives products based on that analysis.

2) PCCW Solutions PCCW Solutions is an IT solution company in China that use the latest technology to achieve successful business value. It is focused on various industries such as manufacture, logistic, food, and retail, financial service, and consumer, and public service, distribution, electronic and healthcare. PCCW solution focus on the shelf that helps to increase the efficiency of shopping in an offline store and at the same time manage the inventory stock and re- stock new items. This solution decreases the chance of things being out-of-stock; therefore, it will not affect the sales. The features for this solution include giving detailed information for each itemto the customers, Real-time stock availability, and stock renewal and enhancing selling products. PCCW uses RFID technology for their solutions. RFID is better

than using a barcode system such as it is available for broader range reading, data encryption, and the ability to rewrite the data. It is also resistant to water and high temperatures; therefore, it is durable. PCCW solutions are integratedwith a cloud that allows it to track and trace globally, increasing data gathering with customer satisfaction and productivity. It also has the feature to scan every packing process with packing provided and early shipment notice. Besides that, it helps in a management system that involves warehouse and asset tracking. They provide a mirror to communicate with the customer in real time and an intelligent shelf.

3)Wise Shelf The wise shelf is a company that focuses on transforming retail stores using IoT technology. Wise shelf developed retail shelves that track information and conditions of the frames in real-time. The sensors are placed inside the rack and able to detect up to 1000 different lights. It also has LED lights to detect the product location and a camera to recognition for the image. The wise shelf gives an alert for low in-stock items, and re-stocking is required by notifying the retailers through the phone. The wise shelf comes up with the idea that the retail store does not have enough employees to manage and control every stock in and out. Therefore, they use sensors to check the movement of every item in the store and detect things that fall. The system is integrated into a mobile app for managers to receive notifications for any changes inside the store. The sensors also help analyses customers' behavior in front of the shelf and detect any movement of products from the shelf. The LEDs that are placed inside the shelf is to emit different colors of light to attract the customer attention. The company also plan to be implementing a beacon on the shelves to communicate with the retailer. Whenever the employees pass the shelf, and the items they carry are on the list, the LEDs will flash. This will help to cut down the time for retail staff to replenish the items in store.

CHAPTER 3

SYSTEM REQUIREMENT SPECIFICATION

3.1 Functional Requirements

- Sensing: The sensors should be able to get readings and send them over to the dashboard for visualization.
- Maneuvering: The robot should be capable of moving on mud without difficulties.
- Connectivity: The IoT sensors and the dashboard system should be connected over a network for data exchange.
- Robustness: The shelf should be robust enough to handle incoming and outcoming products.

3.2 Non-Functional Requirements

- **Security**
  - System needs to control the user access and session
  - It needs to store the data in a secure location and stored in a secure format
  - It requires a secure communication channel for the data.

- **Concurrency and Capacity**
  - System should be able to handle multiple computations executing simultaneously and potentially interacting with each other.

- **Performance**
  - Performance is generally perceived as a time expectation. This is one of the most important considerations especially when the project is in the architecture phase.

- **Reliability**
  - It is necessary to ensure and notify about the system transactions and processing as simple as keep a system log increases the time and effort to get it done from the very beginning. Data should be transferred in a reliable way and using trustful protocols.

- **Maintainability**
  - Well-done system is meant to be up and running for long time. Therefore, it will regularly need preventive and corrective maintenance. Maintenance might signify scalability to grow and improve the system features and functionalities.

- **Usability**
  - End user satisfaction and acceptance is one of the key pillars that support a project success. Considering the user experience requirements from the project conception is a win bet, and it will especially save a lot of time at the project release, as the user will not ask for changes or even worst misunderstandings.

- **Documentation**
  - All projects require a minimum of documentation at different levels. In many cases the users might even need training on it, so keeping good documentation practices and standards will do this task spread along the project development; but as well this must be establish since the project planning to include this task in the list.

3.3 Hardware Requirements

- ESP 32 DEVELOPMENT BOARD
- iBEACON
- HM-10
- USB TO UART
- SMARTPHONE

3.4 Software Requirements

- **Python**
  - The language used for interacting with the neural network. It helps us to build and train the model.
  - Python is an interpreted, high-level, general-purpose programming language invented by Guido Van Rossum and initially published in 1991.
  - Python's design philosophy emphasises code readability and makes extensive use of whitespace. Its language elements and object-oriented approach are aimed at assisting programmers in writing clear, logical code for both small and large-scale projects.
  - Python is trash collected and has dynamic typing. Procedural, object-oriented, and functional programming are among the programming paradigms it supports.
- **Pycharm**
  - PyCharm is a Python Integrated Development Environment (IDE) that includes a variety of key tools for Python developers that are closely integrated to offer a pleasant environment for effective Python, web, and data science development.
- **Tenserflow**
  - Tensor flow is a free and open-source software library for dataflow and differentiable programming that may be used to solve a variety of problems.
  - It's a symbolic math package that's also utilised in neural networks and other machine learning applications. At Google, it's utilised for both research and manufacturing.

CHAPTER 4

DESIGN AND ANALYSIS

4.1 Data Collection & Survey

The primary function of Smart Shelves is to be able to detect the items on the shelf and track them automatically from mobile phone applications. It needs to be able to provide information regarding the current items in real-time. The integration of BLE technology with the application is the key point for the system

4.2 System Design

The proposed iBeacon based Smart Shelves are integrated with IoT devices and mobile applications, which allow the retail staff and store manager to keep track of the inventory online. This system provides real-time data in terms of stock management and maintaining the required temperature on the shelf. Once the items are out of stock, the retail staff and store manager will receive a notification to replenish the items.

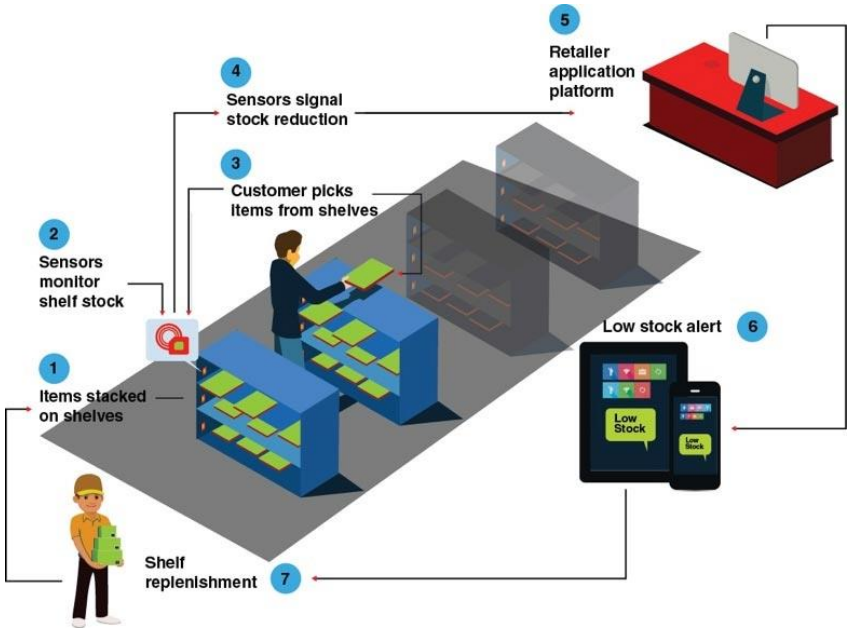

Fig: 4.1 Smart Shelf Technology Shapes Retailing

CHAPTER 5

METHODOLOGY

The overall design of the project revolves around an shelf store which can be used to perform multiple functionalities. The process of building our shelf has been divided into the following steps.

1. Building basic IoT setup to collect data that aids retailers.
2. Building a dashboard to collect data from individual shelf area and visualizing them
3. Building a automated systems.
4. Converting our setups into modules
5. Integrate the modules to work together

Step 1: Building a basic IoT setup

The IoT setup comprises various swappable components. Some of the functionalities include: Product sensing using iBeacon

Step 2: Building a dashboard

A dashboard will be used to present the information being collected from the sensors as mentionedin the previous step. This will then be visualized so that retailers can understand and comprehend figures easily as less knowledge is required. Going forward, a custom dashboard will be built so as to integrate and streamline the various processes involved.

Step 3: Building a App

We build a application.The chassis will be based on the retail store that, however it will be remotely controlled using IoT components.

Step 4: Building modules that work with the application

We build modules that we can attach to the application

- We build the retail components and put it together into one module
- We take the other IoT based setups from step 1 and convert them into modules as well

Step 5: Integrating the modules and Finishing touches

There are some other considerations that come into picture here. For example, we cannot just integrate. We take such considerations into account here to solve them. For example, the above problem can be solved by incorporating an insertion/extraction mechanism for them. Finally, we the finishing touches to our project (like integrating dashboard components) as necessary

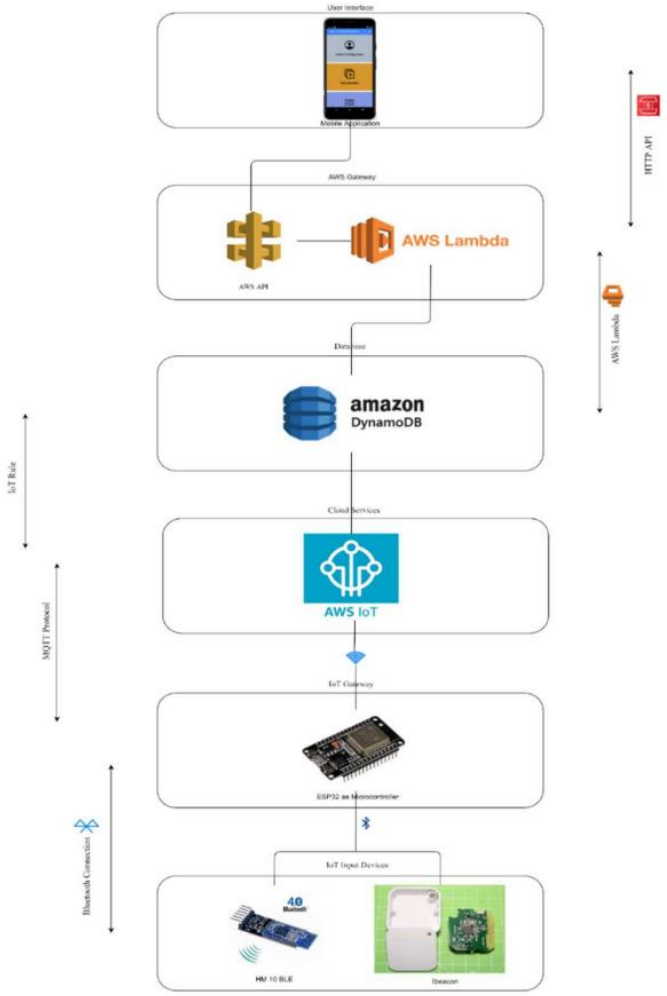

Fig 5.1 Integratinng the modules

CHAPTER 6

CONCLUSION

6.1 CONCLUSION

In this project, we have proposed the implementation of iBeacon based smart shelves for retail stores based on IoT devices. It primarily addresses the issues related to retail stores. We critically evaluated the similar systems and justifies the use of IoT devices and other infrastructural components using a systematic approach, and finally proposed the architecture and recommendations for building the iBeacon based smart shelves for retail stores. Future developmentcan include automatic recognition of the products, indoor mapping navigation function by using ARtechnology and push notification to notify the users directly. Moreover, iBeacons can also be utilized for proximity marketing.

We built a simple, flexible and scalable IoT shelf system. Low cost electronic components were used. We designed and developed the needed software components to have a proof of the prototype concept of our system. We have tested the developed system, and test shows that the concept can beused as a solution to manage shelf inventory and stock replenishment by improving operational efficiencies. Using this system, we can also improve shopper experience, and assure on shelf availability of products. Our system does not use third party servers or components like well-known IoT technology components (MQTT clients and brokers). The sensor data acquisition circuit can be powered by accumulators for mobile shelves. MySQL database can be easily changed to a noSQL database for scalability to reach Big Data size. Just the data model must be changed in the web application. Also, additional custom statistics and data analysis can be developed if needed.

Image processing really seems to be a boon to CPG and Retail organizations. It is an almost zero investment clean technology solution that can be implemented almost immediately. Beyond CPG, many other implementation areas are also possible. For example, one of the garment manufacturers was interested if they can monitor the inventory levels of garments both folded on a shelf and also hung on hangers

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