i-SHOPPING WITH SENSOR FUSION AND CUSTOMER STRUCTURIZATION

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12Z820 - PROJECT WORK II

Dissertation submitted in partial fulfillment of the requirements for the degree of

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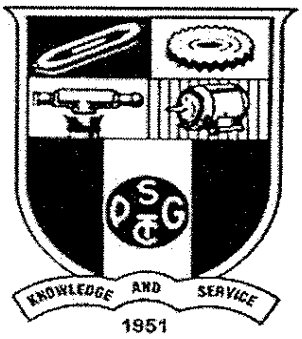
Of Anna University, Chennai.



April 2018

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

PSG COLLEGE OF TECHNOLOGY

(Autonomous Institution)

COIMBATORE - 641 004

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Bonafide record of work done by

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.....	.....
Dr. SANTHI V	**Dr. SUDHA SADASIVAM G**
Faculty Guide	Head of the Department

Certified that the candidate was examined in the viva-voce examination held on .....

.....	.....
(Internal Examiner)	(External Examiner)

CERTIFICATE

Certified that this report titled "**i-Shopping with sensor fusion and customer structurization**", for the Project Work-II (12Z820) is a bonafide work of **Barath M(14z205), Gokul Nithin Kumar R(14z207), Heartlin Karan Machado R(14z214) and Muhammed Suhaib M(14z228)** who carried out the work under my supervision for the partial fulfillment of the requirements for the award of the degree of Bachelor of Engineering in Computer Science and Engineering. Certified further that to the best of my knowledge and belief,the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or an award was conferred on an earlier occasion.

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SYNOPSIS

Nowadays many people are opting for online Grocery shopping because there is no need to hassle at the checkout counters and the process of shopping is fast. While this is true to some extent there is still a research which proves that people find satisfaction in purchasing the products themselves through retail stores rather than online shopping. Our project aims to bridge the gap between these two realms of Grocery shopping. What if people have the liberty to purchase the required products and leave without having to spend unnecessary time at the checkout counters. This could attract more customers to the retail stores and hence increase profits. 'i-Shopping' which is an amalgamation of deep learning techniques with analytical processing aims at removing checkout counters at Retail stores. This is possible through sensor fusion which combines pressure sensors and proximity sensors to determine the presence or absence of an item. Deep learning algorithms can be made applicable to determine the customer behavior and assess which item the customer has picked or returned to the aisles. RFID tags attached to products can be used as a standby to determine the particular item in case of any misinterpretation of the intended product. An android app serves as the medium of communication between the customer and the store. The products are automatically billed to the customer account on the app and the soft invoice is provided to the customers. Also on analyzing the customer's behavior the products which are preferred by the people can be restocked and unnecessary products can be neglected thus increasing the profits.

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CHAPTER 1

INTRODUCTION

Retail Store are indispensable for today's shopping needs. The growing demands of the population in the country is met by the numerous grocery stores set up in the country. But the people who go to these stores for purchases has seen a remarkable decline during the past ten years because of the growing e-commerce and also people consider it as a waste of time to spend around an hour or so for just shopping. People spent a large amount of time worthlessly at the checkout counters where they could be doing several other useful duties. What if a person experiences the comfort of e-shopping while being able to physically see and pick up the products. Our project aims to conceal the distance between these two by removing all the checkout counters from the stores. Sensor fusion makes it possible for connecting all the numerous sensors to automate the process. RFID tags has its impact on the various products by assigning a unique tag to each one of it. NFC is applicable for establishing a link between the central system and the mobile phone. Data analytics plays an important in recommending suitable products to each customer.

1.1. PROBLEM DEFINITION

This project aims at removing all the checkout counters from the grocery stores. Removing checkout counters is not an easy task and requires careful tracking at each stage of the entire process in order to avoid any confusion. A customer should also get the impression of a friendly and approachable grocery store by recommending only the appropriate products. In this way a customer has the satisfaction of picking up the products himself and also saving a considerable amount of time.

1.2. MOTIVATION

Grocery shopping is indispensable in everyday life but the extensive amount of time spent at the checkout counters is making people switch to e-commerce. There is also a survey which tells that people find satisfaction only if they purchased the product in person

themselves. So in order to promote normal retailing the checkout counters must be removed to attract customers. This method greatly impacts the way people do retailing. Hence our approach.

1.3. OBJECTIVE

- To develop a fully functional system that removes the need for checkout counters.
- To provide automated billing systems and just walk out strategy.
- To provide in-store and out-of-store recommendations.
    - In-store recommendations are provided when the customer has his presence inside the premises of the store. These recommendations suggest similar products which the customer has just picked up but at a discounted price.
    - Out-of-Store recommendations are provided when the customer is present exterior to the store. These recommendations make suggestions of buying a product based on the customer's preferred choice of purchase times and also at discounted prices.

CHAPTER 2

LITERATURE SURVEY

DATA MINING FOR THE INTERNET OF THINGS: LITERATURE REVIEW AND CHALLENGES

Feng Chen, Pan Deng, JiafuWan, Daqiang Zhang, Athanasios V. Vasilakos, and Xiaohui Rong (International journal of Distributes Sensor networks, 2015)

Data mining functionalities include classification, clustering, association analysis, time series analysis, and outlier analysis. Classification is the process of finding a set of models or functions that describe and distinguish data classes or concepts, for the purpose of predicting the class of objects whose class label is unknown. Clustering analyzes data objects without consulting a known class model. Association analysis is the discovery of association rules displaying attribute-value conditions that frequently occur together in a given set of data. Time series analysis comprises methods and techniques for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. Outlier analysis describes and models regularities or trends for objects whose behavior changes over time.

CUSTOMER DATA CLUSTERING USING DATA MINING TECHNIQUE

Dr. Sankar Rajagopal (International Journal of Database Management Systems (IJDMS) Vol.3, No.4, November 2011)

Data mining - also known as knowledge-discovery in databases (KDD) is process of extracting potentially useful information from raw data. A software engine can scan large amounts of data and automatically report interesting patterns without requiring human intervention. Other knowledge discovery technologies are Statistical Analysis, OLAP, Data Visualization, and Adhoc queries. Unlike these technologies, data mining does not require a human to ask specific questions. In general, Data mining has four major relationships. They are:
(i) Classes

(ii) Clusters

(iii) Associations

(iv) Sequential patterns.

(i) Classes: Stored data is used to locate data in predetermined groups. For example, a restaurant chain could mine customer purchase data to determine when customers visit and what they typically order. This information could be used to increase traffic by having daily specials.

(ii) Clusters: Data items are grouped according to logical relationships or consumer preferences. For example, data can be mined to identify market segments or consumer affinities.

(iii) Associations: Data can be mined to identify associations. The beer-diaper example is an example of associative mining.

(iv) Sequential patterns: Data is mined to anticipate behavior patterns and trends. For example, an outdoor equipment retailer could predict the likelihood of a backpack being purchased based on a consumer's purchase of sleeping bags and hiking shoes.

CLUSTERING METHODS:

Clustering is a typical unsupervised learning technique for grouping similar data points. A clustering algorithm assigns a large number of data points to a smaller number of groups such that data points in the same group share the same properties while, in different groups, they are dissimilar. Clustering has many applications, including part family formation for group technology, image segmentation, information retrieval, web pages grouping, market segmentation, and scientific and engineering analysis. Many clustering methods have been proposed and they can be broadly classified into four categories: partitioning methods, hierarchical methods, density-based methods and gridbased methods. Other clustering techniques that do not fir in these categories have been developed. They are fuzzy clustering, artificial neural networks and generic algorithms. The following section deals about detailed study of the customer clustering. The data is the production information of our organization smart retail store.

CUSTOMER CLUSTERING:

Customer clustering is the most important data mining methodologies used in marketing and customer relationship management (CRM). Customer clustering would use customer-purchase transaction data to track buying behavior and create strategic business initiatives. Companies want to keep high-profit, high-value, and low-risk customers. This cluster typically represents the 10 to 20 percent of customers who create 50 to 80 percent of a company's profits. A company would not want to lose these customers, and the strategic initiative for the segment is obviously retention. A low-profit, high-value, and low-risk customer segment is also an attractive one, and the obvious goal here would be to increase profitability for this segment. Cross-selling (selling new products) and up-selling (selling more of what customers currently buy) to this segment are the marketing initiatives of choice.

Classification and Regression for Predictive Analysis:

Classification is the process of finding a model (or function) that describes and distinguishes data classes or concepts. The model are derived based on the analysis of a set of training data (i.e., data objects for which the class labels are known). The model is used to predict the class label of objects for which the class label is unknown. “How is the derived model presented?” The derived model may be represented in various forms, such as classification rules (i.e., IF-THEN rules), decision trees, mathematical formulae, or neural networks. A decision tree is a flowchart-like tree structure, where each node denotes a test on an attribute value, each branch represents an outcome of the test, and tree leaves represent classes or class distributions. Decision trees can easily be converted to classification rules. A neural network, when used for classification, is typically a collection of neuron-like processing units with weighted connections between the units. There are many other methods for constructing classification models, such as naive Bayesian classification, support vector machines, and k-nearest-neighbor classification. Whereas classification predicts categorical (discrete, unordered) labels, regression models continuous-valued functions. That is, regression is used to predict missing or unavailable numerical data values rather than (discrete) class labels. The term prediction refers to both numeric prediction and class label prediction. Regression analysis is a statistical methodology

that is most often used for numeric prediction, although other methods exist as well. Regression also encompasses the identification of distribution trends based on the available data. Classification and regression may need to be preceded by relevance analysis, which attempts to identify attributes that are significantly relevant to the classification and regression process. Such attributes will be selected for the classification and regression process. Other attributes, which are irrelevant, can then be excluded from consideration.

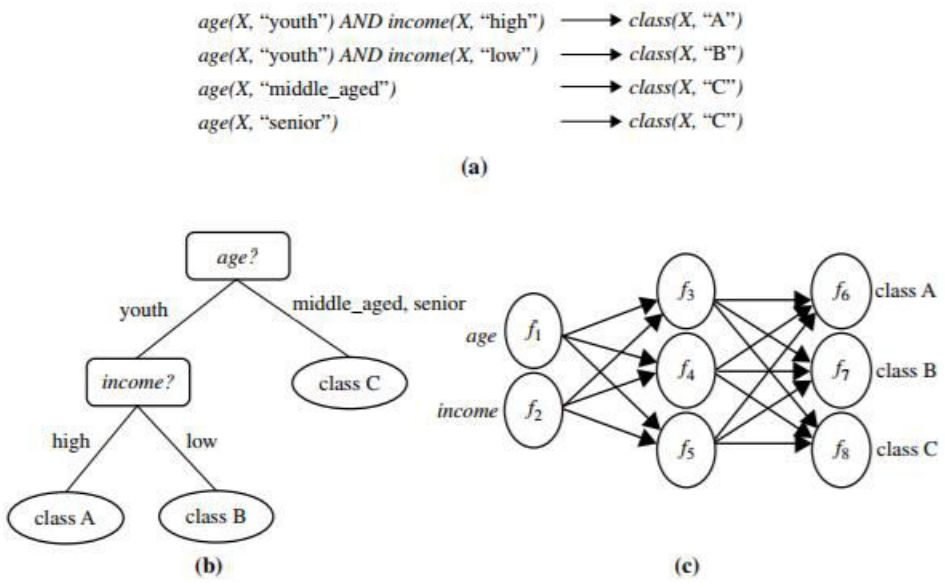


Fig 2.1 Poor Classification using ANN [Source: https://theclevermachine.wordpress.com/2014/09/06/derivation-error-backpropagation-gradient-descent-for-neural-networks/]

AN INTEGRATIVE LITERATURE REVIEW OF SMALL FOOD STORE RESEARCH ACROSS URBAN AND RURAL COMMUNITIES IN THE U.S.

C.A. Pinard , C. Byker Shanks , S.M. Harden, A.L. Yaroch (International journal of Nutrition Science, 2011)

A data extraction tool developed for the purpose of this study utilized the framework of Cooper (1998). Narrative synthesis methods were used to extract and summarize findings from

multiple studies across urban and rural settings. The data extraction tool included the following categories: setting, constructs assessed, measurement tools used, methodology, location, rural versus urban, findings, implications for measurement, and intervention. Each full-text manuscript was independently reviewed by one of two coders (CAP, CBS) and then verified by a second author (CAP, CBS, SMH, or ALY). Inter-rater agreement was verified and multiple coders discussed any conflicts to reach consensus. Results for this small food store review are presented with urban-focused manuscripts first, rural-focused manuscripts, and followed by a comparison of rural and urban findings, each based on the type of study and methodology used. Data were used in a variety of ways to help characterize the urban food environment specific to corner stores. One study characterized shoppers who frequented corner stores utilizing the Consumer Impact Questionnaire and other items for understanding shopping patterns. It was found that low-income inner city residents who visited corner stores shopped more frequently (i.e., daily), traveled shorter distances, tended to use walking as a mode of transportation, and reported purchasing significantly more EDNP foods when compared to supermarket shoppers. Reasons given for shopping at corner stores included convenience, quality, cleanliness, good service, and being within walking distance. In one study, evaluation of food store characteristics showed that corner stores were perceived as "less healthy" and more expensive, when compared to full service grocery stores by consumers. In addition, a larger number of aisles were positively associated with improved availability of more healthful food. Using focus groups and direct observation, another study identified stores that students were visiting and categorized snack foods that students were purchasing. The lack of more healthful snack options and overabundance of pre-packaged. snack foods at these corner stores was demonstrated, as there were no whole fruits or vegetables offered as snacks, and only 4% of all snacks were whole grain. The lack of nutritional variety that exists in corner stores may be, in part, due to the fact that five of the 65 manufacturers that supplied the stores in the assessment neighborhoods accounted for nearly three quarter of all corner store snack food inventories.

ONLINE GROCERY STORE COUPONS AND UNHEALTHY FOODS,UNITED STATES

C.A. Pinard , C. Byker Shanks , S.M. Harden, A.L. Yaroch (PubMed Central, Jan 2005)

There were two rural-based qualitative studies included in this review. In one study, rural residents in the southern U.S. were asked about factors affecting consumption of more healthful foods, food purchasing behaviors, and the perceived availability of healthful items. One significant barrier to healthful eating was the distance to the market, in particular, for low-income, elderly, and rural residents. Many participants reported some nutritional knowledge, but also some misconceptions about foods that they considered healthful. The authors concluded that changes in healthful food access and ultimately consumption of healthful foods in rural areas will happen only through understanding and addressing the experiences, knowledge, and needs of the residents. To date, food access related research has been conducted largely among urban communities, but more recently, attention has been given to the rural counterpart, where health disparities in food access also exist. Our integrated review focused on small food stores in rural and urban settings and highlights the lack of studies conducted in rural settings, with over 70% of the 19 manuscripts reviewed conducted in urban settings. Specifically, rural populations experience greater burden of nutrition-related diseases (such as cardiovascular disease, type two diabetes), economic restrictions, and greater spatial inequality for access to healthful food when compared to urban populations. A recent study identified several potential areas of opportunity to help prioritize a research agenda for studying policies that address rural food access, and described the need for improved food retail systems that allow for a diversity of food retail options, including sufficient access to affordable small markets. Key findings highlighted in the current review of small food stores suggest that the challenges in urban communities stem from the lack of healthy food access among a plethora of unhealthy options, sometimes referred to as a "food swamp," as well as safety concerns. Many residents reported frequenting corner stores in urban areas to purchase EDNP foods. In comparison, the barriers to healthy food access in rural communities are typically associated with transportation issues and an overall lack of access to food outlets. Additionally, studies found a lack of healthy food options in rural stores, largely

because store-owners perceived that their customers would not purchase healthier items. In one paper, both urban and rural stores were assessed, and it was found that the rural stores had the lowest healthy food availability. Further work should be conducted focusing on food access issues in rural communities, and identifying distinctions and parallels are compared to urban settings in order to inform best practices in strategies.

NEAR FIELD COMMUNICATION: TECHNOLOGY AND MARKET TRENDS

Gabriella Arcese, Giuseppe Campagna, Serena Flammini and Olimpia Martucci (US national Library of Medicine,2014)

This literature review is the result of research of NFC related articles, reports and studies. It takes place from the research conducted using search engines Scopus, ISI Web Knowledge, Google Scholar and Google Chrome. According to Haselsteiner and Breitfuß, Near Field Communication is an efficient technology for communications within short ranges, which offers an intuitive and simple way to transfer data between electronic devices. NFC is based on existing contactless technologies, it has an ecosystem that involves many stakeholders and it is compatible with the RFID infrastructures around the world due to the standards mentioned above. NFC devices can receive and transmit data at the same time . Those NFC devices have many functions: they can operate, for example, as a smart contactless card, as a passive RFID tag and as a medium to exchange data between various devices. NFC devices can also be used to exchange data as text, images and URLs simply by holding the device near various smart tags. Hence, NFC has a wide applicability across a wide spectrum of enterprises. Technology in the mobile industry has been moving towards the integration of NFC technology in mobile commerce . The driving force behind NFC is the public increasing dependence on smartphones and the demand for their functionality. This trend opened up many mobile commerce channels that will allow businesses to conduct a huge variety of transactions using NFC technology integrated on mobile devices. In light of these considerations, the many benefits and the potential uses of NFC technology that will continue to push innovations in the field are evident. To understand the NFC technology trend, the Gartner Hype Cycle model is often used. It provides a

graphic representation of the maturity, the adoption rate and the technologies dissemination timing and their applications. Among the examined variables, this model includes the influences generated by the advertising campaigns and the interest rate of consumers . The Hype Cycle curve supplements the information provided by the known S-curve and the diffusion of the technology curve, which respectively identify the trend of evolution and the trade-off between technological change and market growth. Due to the Hype Cycle curve it is possible to understand the trend of future technologies by identifying economic activities, risks, opportunities and innovations that could be useful to CIOs (Chief Information Officer) in the business decision making process . In particular, this curve allows for understanding which direction a technology is taking and how it is been seen by the market. According to the Hype Cycle curve, Gartner, annually releases a report on the future technologies trends. The one released on August 2012 on the estimates for 2012 to 2013 places a greater focus on those technologies that can be used on a large scale. From the observations of the study, the state of Near Field Communication can be identified. It is now placed in the disillusionment phase, in which there is a decreasing rate of media interest. The plateau stage is expected to be reached in the next few years. As a matter of fact, the main infrastructure standards have been finalized and many mobile phone companies have also undertaken the market, by introducing improvements based. on feedback collected following the trials carried out. Furthermore, a downward hype can be a sign of a delay to the diffusion of technology among users.

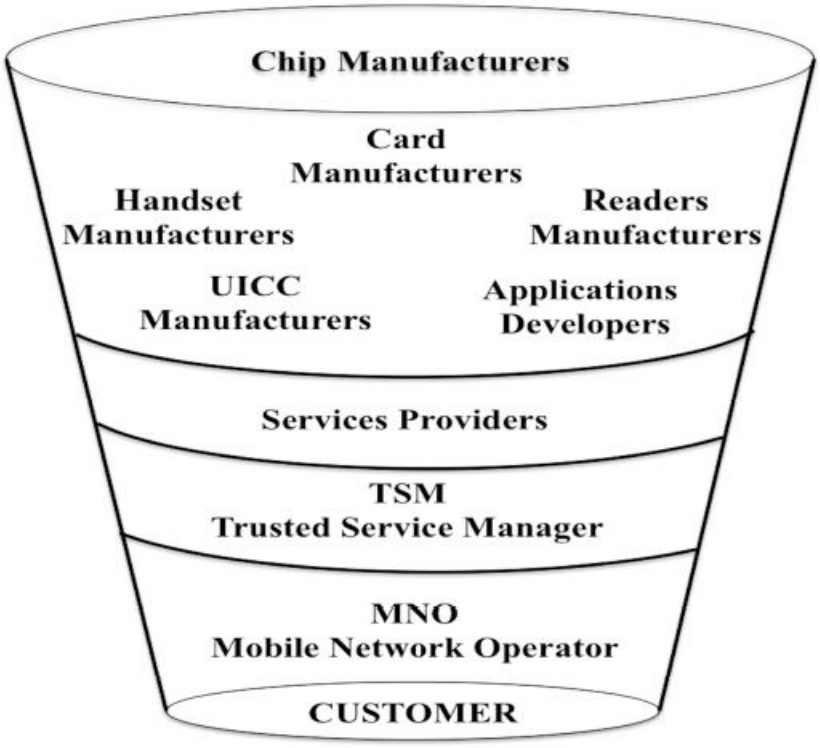


Fig 2.2 Reliability Level of Various Technologies on NFC [Source: https://www.researchgate.net/publication/265363492_Near_Field_Communication_Technology_and_Market_Trends]

RFID TECHNOLOGY PRINCIPLES, ADVANTAGES, LIMITATIONS & ITS APPLICATIONS

Mandeep Kaur, Manjeet Sandhu, Neeraj Mohan and Parvinder S. Sandhu (International Journal of Computer and Electrical Engineering, Feb 2011)

A. NEAR-FIELD RFID

Faraday's principle of magnetic induction is the basis of near-field coupling between a reader and tag. A reader passes a large alternating current through a reading coil, resulting in an alternating magnetic field in its locality. If you place a tag that incorporates a smaller coil in this

field, an alternating voltage will appear across it. If this voltage is rectified and coupled to a capacitor, a reservoir of charge accumulates, which you can then use to power the tag chip. Tags that use near-field coupling send data back to the reader using load modulation. Because any

current drawn from the tag coil will give rise to its own small magnetic field—which will oppose the reader's field—the reader coil can detect this as a small increase in current flowing through it. This current is proportional to the load applied to the tag's coil (hence load modulation). This is the same principle used in power transformers found in most homes today—although usually a transformer's primary and secondary coil are wound closely together to ensure efficient power transfer. However, as the magnetic field extends beyond the primary coil, a secondary coil can still acquire some of the energy at a distance, similar to a reader and a tag. The reader can then recover this signal by monitoring the change in current through the reader coil. A variety of modulation encodings are possible depending on the number of ID bits required, the data transfer rate, and additional redundancy bits placed in the code to remove errors resulting from noise in the communication channel. Near-field coupling is the most straightforward approach for implementing a passive RFID system. Figure 1. Near-field power/communication mechanism for RFID tags operating at less than 100 MHz. However, near-field communication has some physical limitations. The range for which we can use magnetic induction approximates to $c/2\pi f$, where c is a constant (the speed of light) and f is the frequency. Thus, as the frequency of operation increases, the distance over which near-field coupling can operate decreases. A further limitation is the energy available for induction as a function of distance from the reader coil. The magnetic field drops off at a factor of 1/r3, where r is the separation of the tag and reader, along a center line perpendicular to the coil's plane. So, as applications require more ID bits as well as discrimination between multiple tags in the same locality for a fixed read time, each tag requires a higher data rate and thus a higher operating frequency. These design pressures have led to new passive RFID designs based on far-field communication.

B. FAR-FIELD RFID

RFID tags based on far-field emissions capture EM waves propagating from a dipole antenna attached to the reader. A smaller dipole antenna in the tag receives this energy as an alternating potential difference that appears across the arms of the dipole. A diode can rectify this potential and link it to a capacitor, which will result in an accumulation of energy in order to power its electronics. The technique designers use for commercial far-field RFID tags is back scattering . If they design an antenna with precise dimensions, it can be tuned to a particular

frequency and absorb most of the energy that reaches it at that frequency. However, if an impedance mismatch occurs at this frequency, the antenna will reflect back some of the energy (as tiny waves) toward the reader, which can then detect the energy using a sensitive radio receiver. By changing the antenna's impedance over time, the tag can reflect back more or less of the incoming signal in a pattern that encodes the tag's ID. In practice, you can detune a tag's antenna for this purpose by placing a transistor across its dipole and then turning it partially on and off. As a rough design guide, tags that use far field principles operate at greater than 100 MHz typically in the ultra high-frequency (UHF) band (such as 2.45 GHz); below this frequency is the domain of RFID based on near-field coupling.

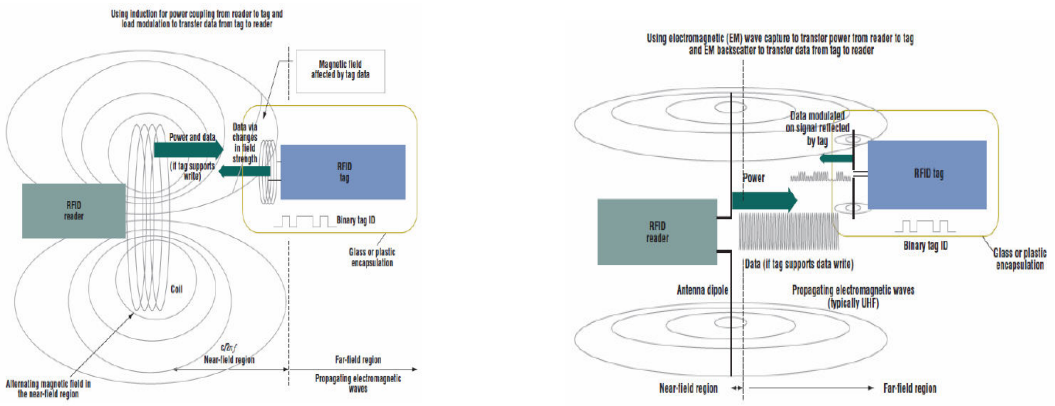


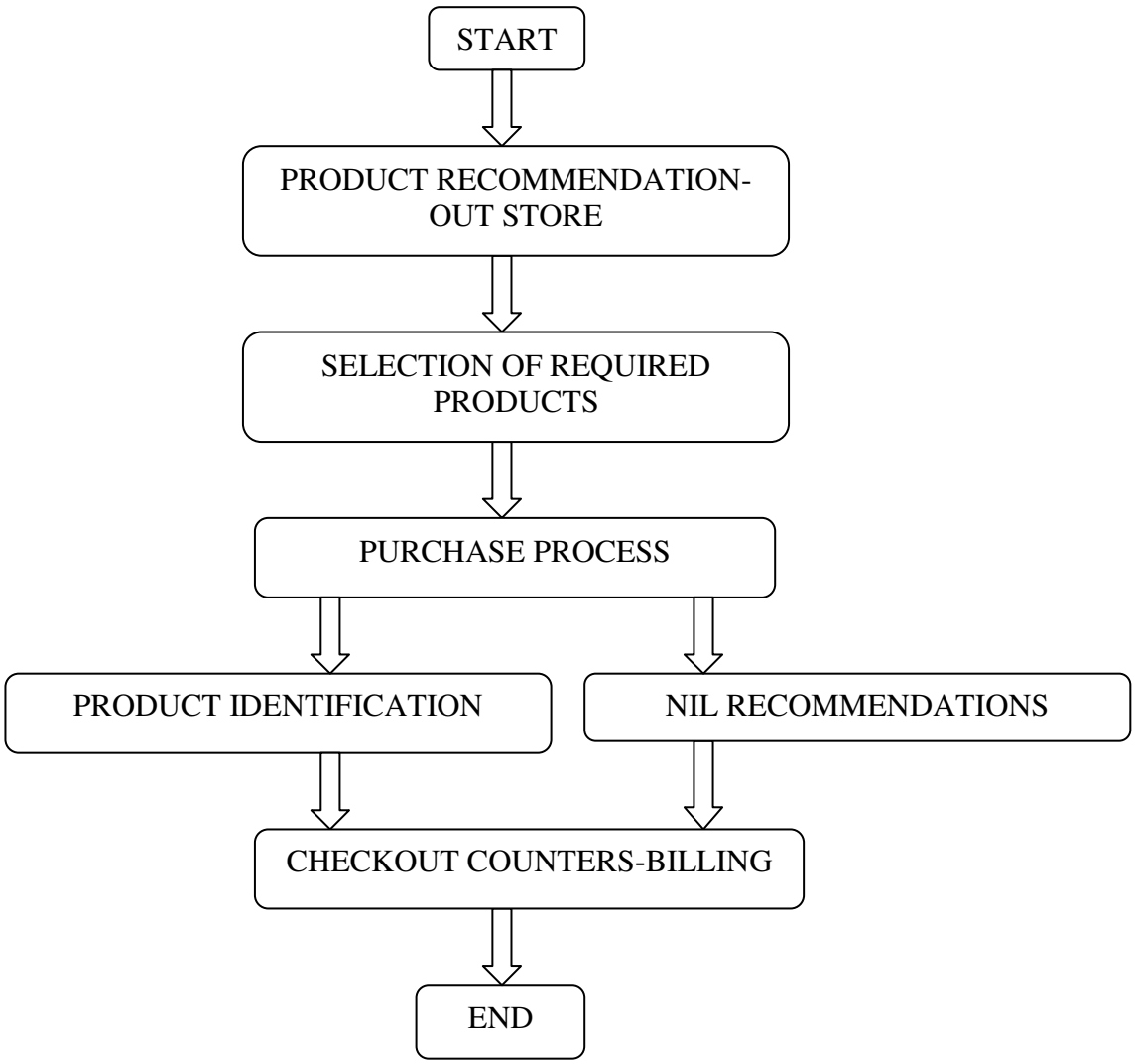
Fig 2.3 Diagrammatic representation of near field and Far Field RFID[Source: https://www.engineersgarage.com/articles/passive-rfid-tags]

CHAPTER 3

SYSTEM DESIGN

3.1 EXISTING SYSTEM

3.1.1 FLOWCHART OF THE EXISTING SYSTEM



STEP 1: PRODUCT RECOMMENDATION-OUT STORE

The existing system provides out store recommendations where the products which are currently discounted by the shops would be intimidated to the customer. These include current prices, time until which the offer will be valid at preferable locations. These recommendations however suffer from the drawback of not providing suitable purchase timings and could suffer from out-of-stock shortages.

STEP 2: SELECTION OF REQUIRED PRODUCTS.

Customers must select the required products by browsing through the stands and no kinds of assistantship are provided. This selection is traditional and includes a lot of human effort and lacks customer satisfaction. Once a product is selected, no kind of quick in-store recommendations are notified to the customer.

STEP 3: PURCHASE PROCESS

Purchase process is out dated and requires a lot of refinement.

PRODUCT IDENTIFICATION

Customers must identify which are the required products and pick up from the stands. In case of any mismatch then the entire selection process must be repeated to satisfy the requirements.

NILL RECOMMENDATION

There are almost nill instore recommendations, which is essential for efficient shopping trends. Whenever a customer picks up a product there is always a similar recommendation which tells the customer about a similar product which reduced pricing.

STEP 4: CHECKOUT COUNTERS-BILLING

This is one of the main drawbacks of the existing model where the customer must wait for a certain period of time unnecessarily at the checkout counters. This reduces the interest of the customers to visit the store again. Survey suggests that the time spent at the checkout counters could be well utilized for essential activities or useful events.

DISADVANTAGES OF EXISTING SYSTEM

- Long checkout counters which waste's customer's valuable time, an average of 25 customers per hour.

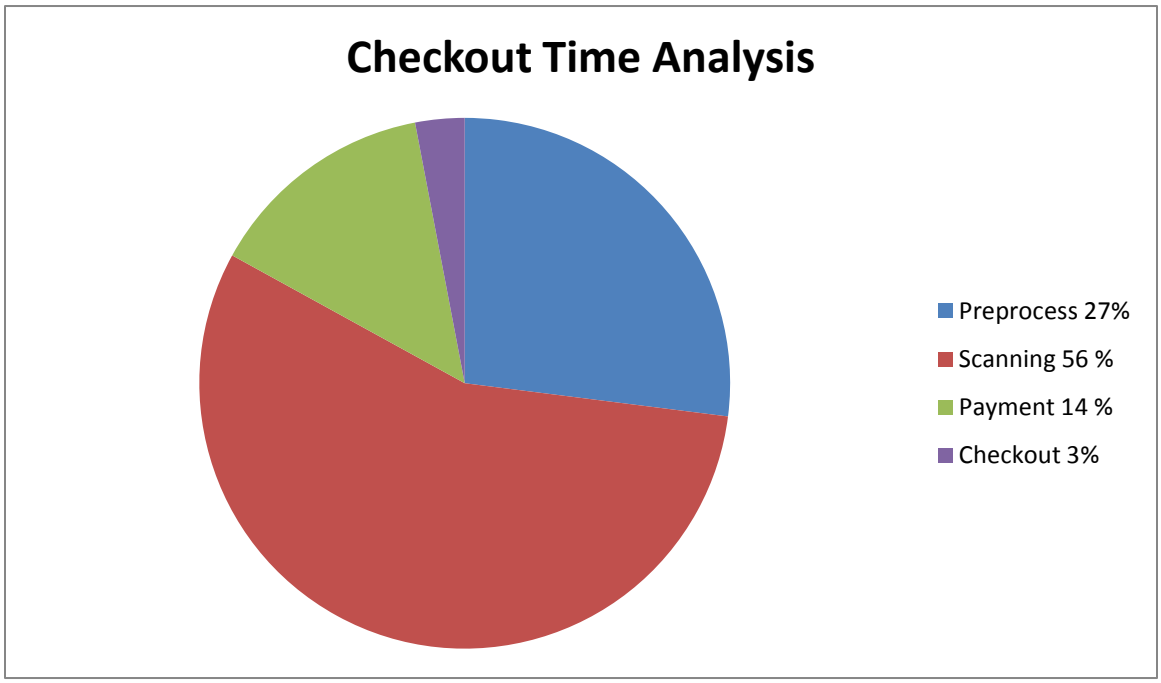
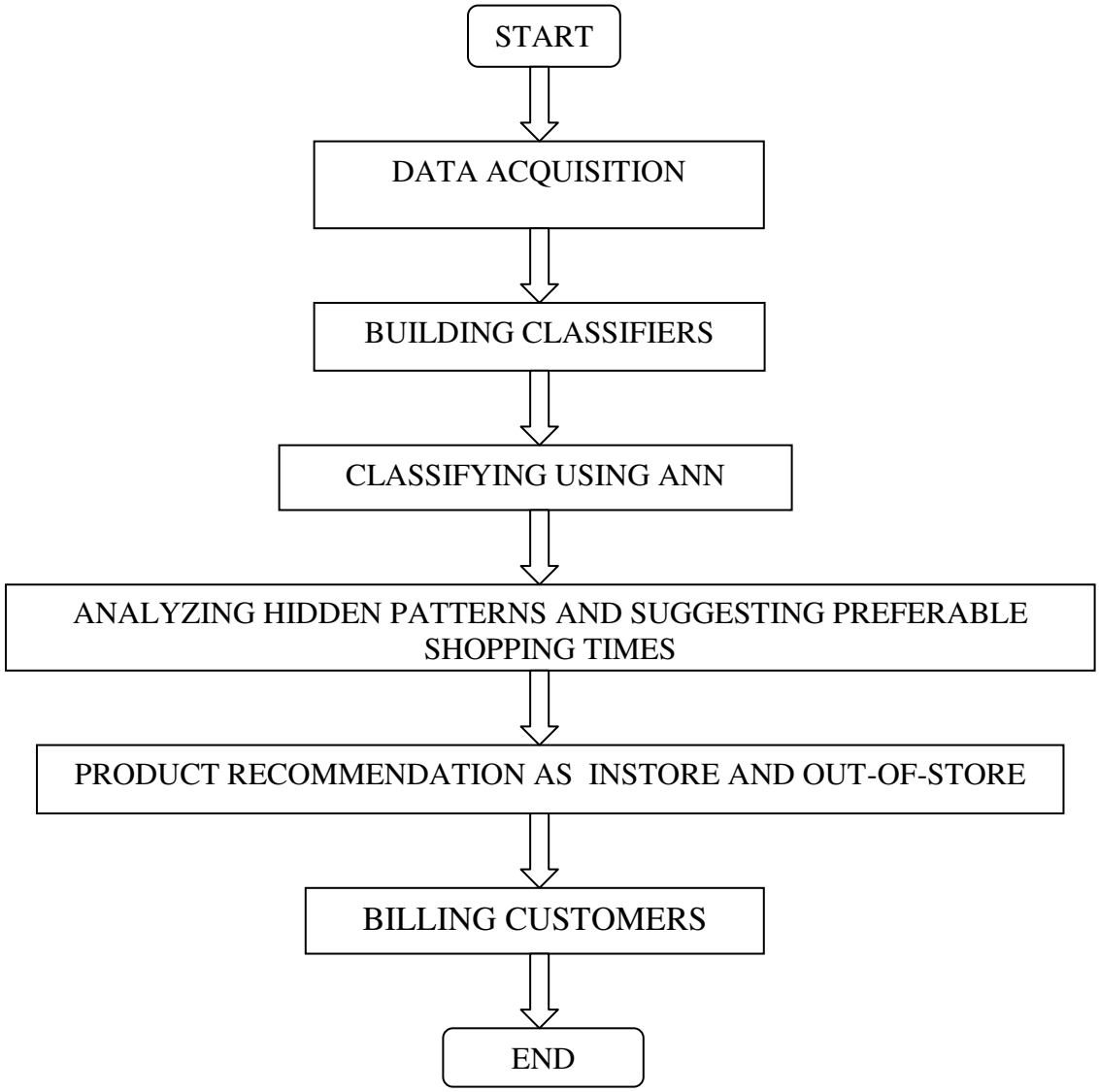


Fig 3.1 Checkout Time Analysis [Source: http://www.atkearney.com.au/paper/-/asset_publisher/dVxv4Hz2h8bS/content/recasting-the-retail-store-in-today-s-omnichannel-world/10192]

- Shopping made store centric and not customer centric.
- Large number of store keepers necessary for maintenance.

3.2 PROPOSED SYSTEM

3.2.1 FLOWCHART OF THE PROPOSED SYSTEM



STEP 1: DATA ACQUISITION

The dataset for the proposed system is true and authentic and is acquired from the Whole foods, Publix Markets and Spar Supreme. The dataset is updated daily and contains purchase history of all the customers of UK, Germany, France, Eire, Spain, Netherlands, Belgium, Switzerland, Portugal, Australia, Norway, Italy Channel Islands, Finland, Cyprus, Europe, America and Asia. The Dataset has a total of 9 attributes and 5,41,910 rows. This dataset is categorized based on countries since each country has its own purchasing behavior. Further attributes in the dataset includes, product description, quantity, date of purchase, unit price and total purchase amount. These datas are analyzed in order to form the training sets for the recommendation systems.

STEP 2: BUILDING CLASSIFIERS

The Supervised Machine Learning Algorithm, Artificial Neural Networks is used to initially to classify the dataset based on the purchase amount as premium and regular customers. This helps the system in suggesting appropriate recommendations for each set of customers and also helps in correctly predicting any new customer who registers with the shop about his purchase behavior.

GRAPH CONSTRUCTION

After categorizing the customer based on class, a graph is constructed with respect to the decision boundary. Decision Boundary is one that highlights the purchase behavior of each class of customer. There are certain classes for which Decision Boundary cannot be constructed, in such cases the behavior of various classes of customers seem to correlate with each other and separation of classes becomes impossible.

STEP 3: ANALYZING HIDDEN PATTERNS AND SUGGESTING PREFERABLE SHOPPING TIMES

All kinds of hidden patterns must be found out in order to give the most apt recommendations to each customer. These hidden patterns vary across a wide range of fields such as purchase frequency, items of purchase, purchase quantity etc.

STEP 4: APRIORI ALGORITHM

Apriori algorithm is used to find out the association between the products purchased and the time of purchase. Different countries have different purchase times and the customers prefer to purchase at their convenient times. Thus, intimidating at the prime purchase may trigger more customers to visit the grocery stores.

STEP 5: PRODUCT RECOMMENDATION AS IN STORE AND OUT-OF-STORE

There are typically two types of recommendations as In store and Out-of-store. Instore recommendations are used when the customer is shopping inside the store and appropriate recommendations must be sent when the customer picks up a particular product. These recommendations advise a customer if there is a similar product but with a reduced price.

Out-of-store recommendations are used when the customer is outside of the shop and such recommendations inform the customers of upcoming and currently available discounts. These recommendations are useful in luring customers to visit the store again, hence increasing sales.

STEP 6: DATABASE INTEGRATION

The customers who visit the store are logged into a database which serves as the backend of the entire system and the android application. All kinds of purchases and recommendations are also logged so that they may be retrieved whenever needed and stored without any contingency. Time synchronization is necessary since this system functions in real time and needs careful time synchronization.

STEP 7: RFID TAGS(PRODUCT IDENTIFICATION)

Radio Frequency Identification(RFID) is used to identify which products have been picked up from the stands. These tags comes embedded with all the products and have a unique identification so it acts as the means of product identification and can be easily set up. When a customer places a product inside the cart the RFID sensor equipped with the cart identifies the product and bills the customer with the product's price.

STEP 8: NFC TAGS(MOBILE PHONE IDENTIFICATION)

Near Field Communication(NFC) is used to establish communication between the central system and the mobile phone.NFC enabled mobile phones are placed on a stand placed on the trolley which establishes a link between the phone and the store's central system. When a customer approaches a stand the NFC tags embedded with the android phones establish a wireless link with the computer and can be efficiently used for the billing and recommending process with respect to the particular customer.

STEP 9: USER INTERFACE (FRONT-END)

ANDROID APP

An Android app serves as the user interface where the customer would scan his barcode, get the invoice and also receive all kinds of recommendations. This app has two kinds of interfaces as the Retail interface and out store interface. Retail interface has the instore kind of interface where the customers would get recommendations, preview his cart and also receive invoice if successfully billed. The other kind of interface is out store interface where the customer would only receive recommendations of various products at their best prices at our convenient times. There is also an option of adding new customers to the system where the customer would give his details and get a unique QR-code for future use of the system.

3.3 WORKING PROCESS

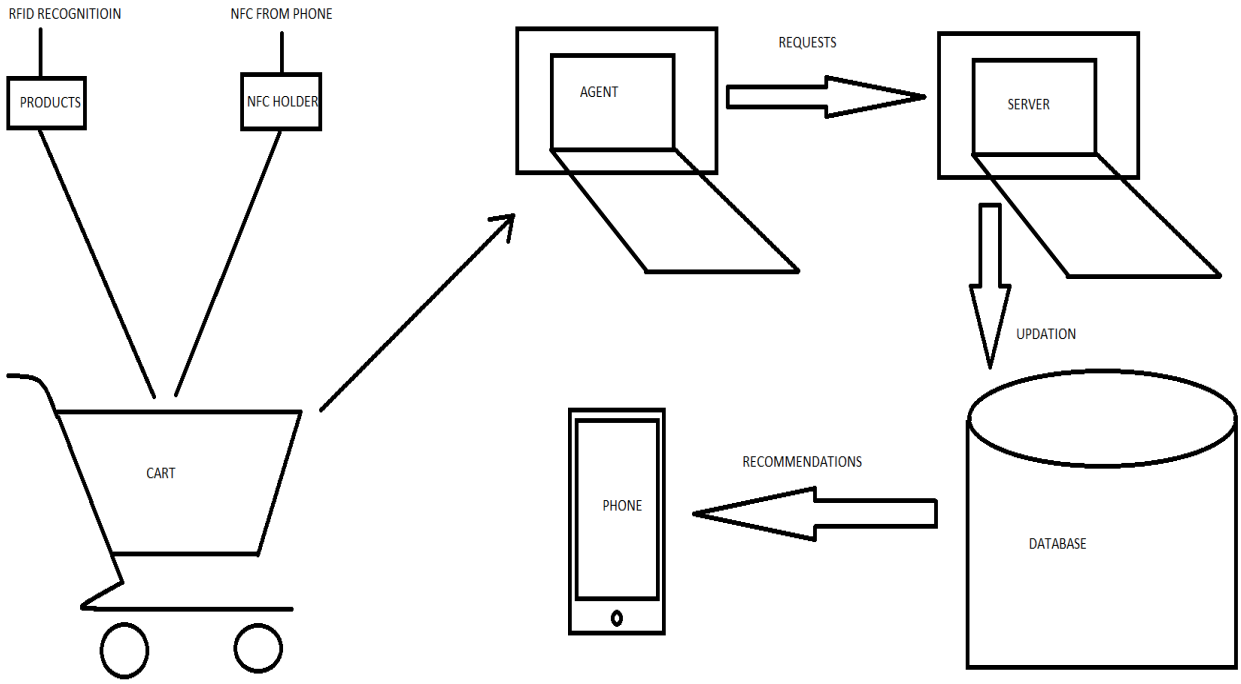


Fig 3.2 Block Diagram of the i-System

Initialization: The customer scans his phone through the QR-code provided and enter the store.

Step 1: On entering the store the customer places his phone on the NFC reader embedded with the cart. The phone's NFC tag communicate with the NFC reader equipped with the cart. A link is established between the phone and the store's server.

Step 2: The customer picks up the product he wishes and places them inside the cart. These products must pass through the cart's RFID reader and gets updated in the Customer's android phone.

Step 3: The cart sends the message to the agent which in turn sends the message to the server for updating the database.

Step 4: The database is synchronized with the customer's preferences and the appropriate product is aptly billed in the customer's e-cart.

Step 5: If the customer wishes to replace the product steps2-3 are repeated and the database gets updated again.

Step 6: The customer must again scan his phone while exiting and the products invoice is sent to the customer's account and email id.

Step 7: The purchase process is done through the payment gateway simultaneously while exiting the store.

Step 8: The products are billed and the customer has finished his purchase

CHAPTER 4

SYSTEM REQUIREMENTS

4.1 SOFTWARE REQUIREMENTS

OS : Windows

Tools : Python IDE, Eclipse IDE, MySQL Work Bench, Arduino IDE, TWedge (Sensing medium).

4.2 HARDWARE REQUIREMENTS

RAM : Minimum 16 GB

PROCESSOR : Intel i7

MEMORY : Minimum 100 GB

GRAPHICS : 8 GB NVIDIA 1080 Ti.

Sensors : RFID reader, NFC reader, QR-code Scanner.

Tags : RFID tags, NFC tags

Server : WAMPP

4.3 TESTING PLATFORMS

- PC
- Android

4.4 LANGUAGES

- Python
- Arduino
- SQL
- PHP

4.5 USERS OF THE SYSTEM

The customers who visit the store for purchasing various products from the store are the users of the system. All the existing customers can use the android app to interact with the store or for receiving various kinds of recommendations. Any new customer can register with the app for further

interactions with the system and the store. Each customer has a unique QR-code which functions as the means of identifying each unique customer.

4.6 FUNCTIONAL REQUIREMENTS

The users must provide valid login credentials to register with the system. When a user enters into the store he must scan the QR-code and also while exiting. New users are required to register by providing their email-id and a new unique QR-code will be sent to their email which serves as the point of communication for future use. This QR-code serves as the point of contact between the system and the visiting customer.

4.7 NON-FUNCTIONAL REQUIREMENTS

The system provides the solution for the problem in finite amount of time. Here, the problem refers if the system does not update the cart in correct timestamp or if wrong products are updated to the cart. In such cases the support system contacts with the duplicate database and solves any crashes. The user can also seek the help of support staff to resolve their issues. When the system experiences a glitch in its functioning then the secondary server performs overclocking until the error is rectified.

CHAPTER 5

DATA ACQUISITION

The dataset for the proposed system is true and authentic and is acquired from various super markets across different continents. The dataset is updated based on customer's purchase records. The Dataset has a total of 9 attributes and 5,41,910 rows. Further Datasets includes the Description, Quantity purchased, Unit Price, Country of purchase of each customer. These datasets are analyzed in order to form the training sets for the prediction model.

5.1 DATASET

The following are the datasets are being used for training and testing

- Whole foods (USA & UK) – 546MB [20]
- Publix markets(Europe and Asia) - 671MB [21]
- Spar supreme(Africa) – 325MB [22]

5.2 DATASET PRE-PROCESSING

The Datasets must be pre-processed in order to fit the data for further classification. We must first clean the data, integrate them and then transform it to the desired processing format. The Not Applicable values are removed from the dataset in order to make the data suitable for all types of processing. The Dataset is split up based on the countries and the processing is done for country based product purchases.

Attributes	**Data type**	**Description**
Invoice No	Number	Bill ID
Description	Plain Text	Product Description
Quantity	Number	Quantity of the purchased product
Unit Price	Float	Individual price of the product.
Customer ID	Number	Unique ID of the customer.
Country	Number	Country of purchased product.
Total	Float	Total price of the product
Date	Date & Time	Date & Time when the product was billed

Table 5.1 Supermarket purchase Dataset Attributes

Description and Quantity are two important attributes which must be taken into account for finding out the different classes of customers. Time from the date attribute is pivotal for suggesting suitable purchase times. These help in providing out store recommendations.

CHAPTER 6

DESCRIPTIVE ANALYSIS

The fundamental step for any project in Data Science is Descriptive Analysis. It describes the basic features that are going to be implemented in the project. It provides simple summaries about what the project is all about. It also projects the various features involved in the project and the dependencies between the projects. Descriptive Analysis also includes Inferential Statistics that provides new inferences with proof with the help of raw data.

6.1 INFERENCES FROM RAW DATA

6.1.1 CUSTOMER TYPES CHART

This chart deals with categorizing customers as Premium or Regular based on their purchasing behavior. Customers who have purchased products for more than $ 1000 /- are considered as PREMIUM customers and others are considered as REGULAR customers, because Premium customers tend to purchase more products hence providing recommendations to such customers would lure them to buy that product thereby increasing profit to the shops.

Customers			
Type	Premium	Regular	Total
Count	1638	2734	4372.00

Table 6.1 Customer types chart

6.1.2 COUNTRY CONSIDERATION CHART

This chart includes the list of countries that would be considered in this project. As this project involves a pretty high investment into it, countries where the customer count is less would not be cost efficient. So in order to be cost efficient this analysis is done. Two features decide whether the country will be considered or not. Firstly, the customer count is taken into consideration. Countries where the customer count is greater than 500 are considered.

$$Customer\ Individual\ Contribution = \frac{Gross\ Amount}{Customer\ Count}$$

Countries Under Consideration	
Total	38
Considered Countries	16
Not Considered	22

Table 6.2 Country consideration chart

6.1.3 PRIME TIME RECOMMENDATION CHART

This is the most important chart for recommendation based systems. Recommendation's cannot be provided to customers at any point of time, for example, providing recommendation to customers at 3:00 AM will have more probability for the customer to delete the recommendation. Hence in order to overcome this issue Prime Time is calculated for every country. For calculating the prime time, Customers purchase time is taken into consideration and its frequency is calculated. Then a graph is plotted between Frequency and Purchase Time. The graph then summarizes the prime time for that country.

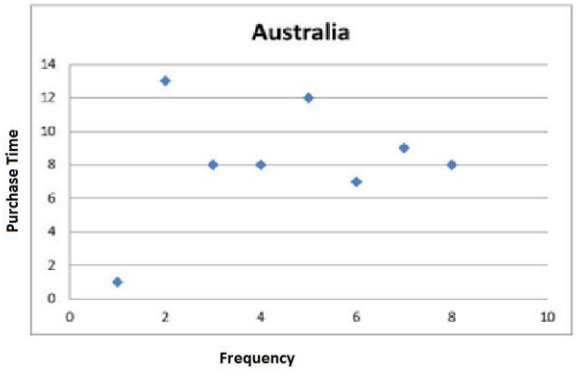


Fig 6.1 Purchase Frequency Graph

6.1.4 PRODUCT RECOMMENDATION CHART

Recommending products is based on two factors. Firstly, it depends on the count of each product brought during the period (sorted in descending order). Secondly, it based on the Cumulative Frequency of the gross total of each product. After applying these two filters, the products that are responsible for 80% of the gross total are considered for recommendation.

Product Based Recommendation	
Total products	4207
Products for recommendation	832
Products not considered	3375

Table 6.3 Product recommendation chart

6.1.5 DISCOUNT FOR PREMIUM AND REGULAR CUSTOMERS CHART

After filtering out the products that are to be recommended to the customers, they are again categorized based on which type of customers (whether premium or regular) and what products they buy. After this categorization the list is sent to the respective shops so that whenever the shop admins update the discounted value for a particular product, the recommendation will be automatically sent to the respective customers during their prime time.

Product Recommendation for Premium Customers				
Sl No	**Description**	**Unit_Price**	**Dis_Percent**	**Reduced_Price**
0	SKULLS DESIGN COTTON TOTE BAG	2.25	44.40%	1.25
1	SET OF 6 SOLDIER SKITTLES	3.75	15.74%	3.16

Table 6.4 Product Recommendation for Premium Customers chart

Product Recommendation for Regular Customers				
Sl No	**Description**	**Unit_Price**	**Dis_Percent**	**Reduced_Price**
0	20 DOLLY PEGS RETROSPOT	1.25	45.44%	0.68
1	ASSORTED BOTTLE TOP MAGNETS	0.36	47.99%	0.19

Table 6.5 Product Recommendation for regular Customers chart

Note: For testing purposes the Discount % is provided at random to the customers.

CHAPTER 7

RECOMMENDATIONS - INSTORE & OUT-OF-STORE

The Supervised Machine Learning Algorithm ,Artificial Neural Networks is used to categorize the class of customers as premium and regular. This enhances the durability for making appropriate recommendations to the customers since only the specific class will be analyzed for making the suitable recommendations.

7.1 ARTIFICIAL NEURAL NETWORKS

Product Recommendation plays a pivotal role in finding out which products the particular customer picks up and places back. So Artificial Neural Networks makes it possible by analyzing the past shopping behavior of the customers.

ANN Formula:

$$C = \frac{1}{N}\sum_{i=1}^{N}(f(Xi) - Yi)^2$$

Algorithm:

1. Net result of hidden state 1

$$NET\ h1 = w1 * i1 + w2 * i2 + b1 * 1.$$

where,

w - weights of layer n

i - input layer activation function

h - Hidden layers

2. Output emergence of hidden state 1 using the logistic function

$$OUT\ h1 = \frac{1}{1 + e^{-NET\ h1}}$$

3.Net Output result

$$OUT\ o1 = \frac{1}{1 + e^{-NET\ o1}}$$

4. Summation of next step average of the target with respect to the output which gives the total error.

$$E\ total = \sum \frac{1}{2}(target - output)^2$$

5. Target output for o1

$$E\ o1 = \frac{1}{2}(target\ o1\ - out\ o1)^2$$

6. Total summation up output comprising of all the hidden states

$$E\ total = E_{01}\ \ + E_{y02}$$

HIDDEN LAYER

1. Total change calculation

$$\frac{\partial Etotal}{\partial w1} = \frac{\partial Etotal}{\partial OUT\ h1} * \frac{\partial OUT\ h1}{\partial NET\ h1} * \frac{\partial NET\ h1}{\partial w1}$$

∂ - Change in calculations

2. Change of Total error with respect to the output

$$\frac{\partial Etotal}{\partial OUT\ h1} = \frac{\partial Eo1}{\partial OUT\ h1} + \frac{\partial Eo2}{\partial OUT\ h1}$$

3. Change in error calculation

$$\frac{\partial Eo1}{\partial OUT\ h1} = \frac{\partial Eo1}{\partial NET\ o1} * \frac{\partial NET\ o1}{\partial OUT\ h1}$$

4. Total change of net input of o1 change with respect to w5

$$NET\ o1 = w5 * OUT\ h1 + w6 * OUT\ h2 + b2 * 1$$

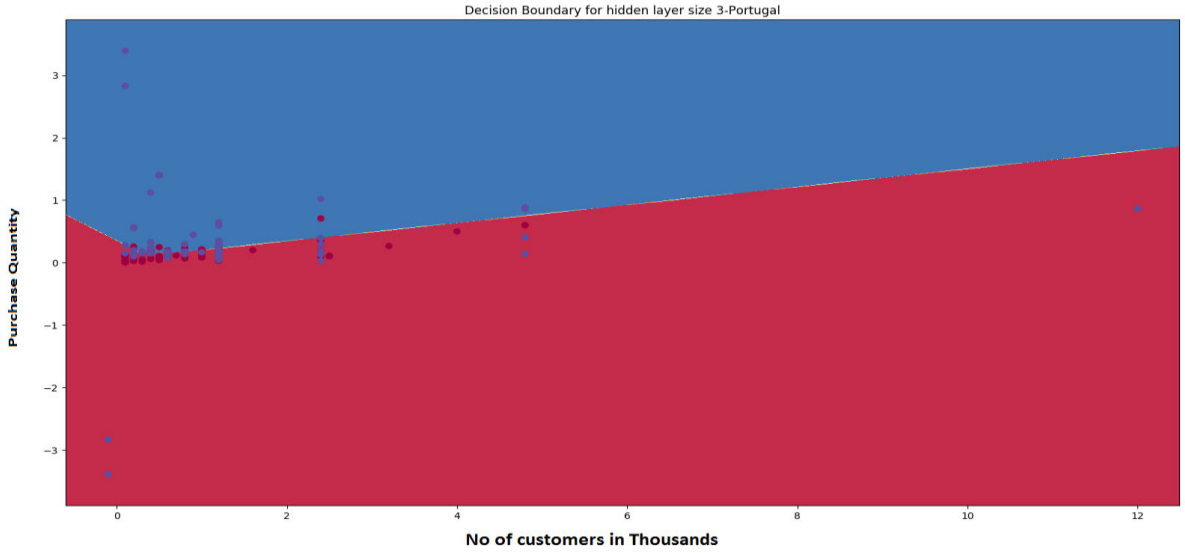


Fig 7.1 ANN Decision Boundary split

After recognizing the different classes of customers, the decision boundary is constructed segregating the different classes of customers. Once a customer enters a shop his shopping trends are immediately recognized and plotted accordingly.

7.2 INSTORE

After splitting the different classes of customers the recommendations are provided as instore when a customer finds himself inside the store.

7.2.1 SIMILARITY BASED RECOMMENDATIONS

Similarity based recommendations is based on the principle of suggesting similar products which the customer has picked up but offered at a reduced price. Multiple recommendations should not be encouraged as it gives the wrong impression to the customers that the shop is trying to push its products just for the sake of profit and doesn't care anything about customer's satisfaction.

Apriori Algorithm

Apriori Algorithm recognizes Hidden Patterns by considering different attributes in the dataset and provide their occurrence and confidence levels based on their associativity between the attributes.

Algorithm:

C_k = candidate itemset of size k.

L_k = frequent itemset of size k.

L_1 = {frequent items }

k=1

while ($L_k \neq \emptyset$)

{

C_{k+1} = candidates generated from L_k .

For(each transaction)

Increment count of candidates in C_{k+1}

L_{k+1} = candidates in C_{k+1} with sufficient support

k=k+1

}

1. Support itemset frequency.
   Support - Popularity of an itemset

2. Confidence X→Y
   Confidence - Likeliness that itemset Y is purchased when X is purchased
   Conf(X→Y)=supp(XY)/supp(X) i.e P(Y/X)

3. Lift association of X and Y.

   lift - Likeliness that itemset Y is purchased when X is purchased while controlling popularity

   Lift(XY)= supp (XY) / (supp(X) * supp(Y))

4. Conviction X→Y

   Conv(X→Y) =(1-supp(Y)) / (1-conf(X→Y))

Attribute	Function
Description	Similar product recommended
Time	Suitable timing recommended
Country	Country of recommendation

Table 7.1 Apriori functionalities

7.3 PYTHON GENERATOR FUNCTION

For making appropriate suggestions we apply the python generator function instead of standard association function since each suggestion must be made in accordance with the timestamp of the central system and coordination must be maintained. The Apriori algorithm with the standard association function takes the entire set of data as input as processes it. This increases the computation time hence to overcome this situation, hence to overcome this situation python generator function is used that take each tuple from the database as input and processes it. This results in quicker computation and reduces time complexity.

7.4 OUT-STORE-RECOMMENDATIONS

Out Store recommendations refer to the process of suggesting product recommendation when the customer is out of the store. Here the suggestion would come in the form of messages suggesting customer's to make the purchase at their convenient times. These

messages play the role of luring the customer's to make the purchase at their leisure time based on each country's behavioral pattern. Out-store recommendations are useful when the store requires new set or new biased customer who would make the effort to come to the store to make the purchase. Apart from making these recommendations the stocks are frequently checked to see if the discounts are applicable or if any case the discounted products are out-of-stock.

DISCOUNT PERCENTAGES:

The Discount percentages are given based on the suggested discount ranges published from the supermarket themselves. These percentages vary from product to product and have the pricing strategies adopted based on set principles. Discount percentages vary from time to time and the best price at each stage has to updated at each point to obtain the slashed prices.

Country	Time
Australia	9am
Belgium	1pm-3pm
Norway	12pm-2pm
Sweden	11am-3pm

Table 7.2 Suitable Timing(country wise)

CHAPTER 8

EMBEDDED SYSTEMS

For identifying whether a customer has entered the store and also for identifying which particular product the customer has picked up RFID tags and its corresponding reader is used. For establishing connection between the android and central system NFC tags and a suitable Near Field Communication(NFC) reader is used.

8.1 NEAR FIELD COMMUNICATION (NFC)

NFC-enabled portable devices can be provided with application software, for example to read electronic tags or make payments when connected to an NFC-compliant apparatus. Earlier close-range communication used technology that was proprietary to the manufacturer, for applications such as. Like other "proximity card" technologies, NFC employs electromagnetic induction between two loop antennas when NFC-enabled devices—for example a smartphone and a printer—exchange information, operating within the globally available unlicensed radio frequency ISM band of 13.56 MHz on ISO/IEC 18000-3 air interface at rates ranging from 106 to 424 kbit/s.

Each full NFC device can work in three modes:

NFC card emulation

Enables NFC-enabled devices such as smartphones to act like smart cards, allowing users to perform transactions such as payment or purchasing.

NFC reader/writer

Enables NFC-enabled devices to read information stored on inexpensive NFC tags embedded in labels or smart phones.

NFC peer-to-peer

Enables two NFC-enabled devices to communicate with each other to exchange information in an adhoc fashion.

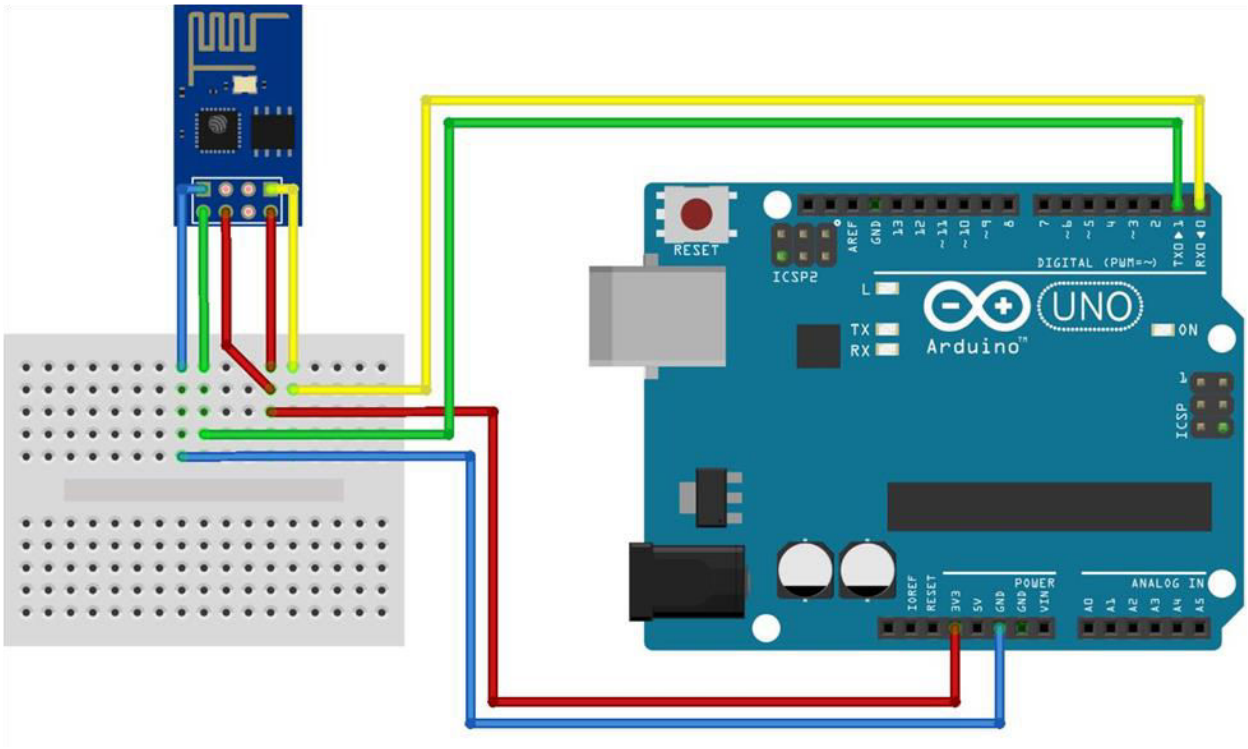


Fig 8.1 NFC-ARDUINO pin configuration

8.1.1 NFC TAGS

NFC tags embedded in android phones help in communicating with the NFC reader attached with the cart. Once an Android phone is placed on the reader a NFC communication is established between the phone and the cart. Phones manufactured before 2011 have no NFC tags, in such cases a new NFC tag can be assigned to the android phone in the form of a sticker.

Fig 8.2 NFC tag

NFC has the advantage of using it by the application of wireless connections, through the interaction between the system and the android app. But it is unable to send transmission messages over long distances, in such cases a different transmission medium must be used to relay the message between the two ports. This medium must have the ability to receive local information from each customer's shopping cart and rely it to the central system.

8.2 RADIO FREQUENCY IDENTIFICATION (RFID)

RFID tags can be attached to cash, clothing, and possessions, or any kind of grocery item. These concerns resulted in standard specifications development addressing privacy and security issues. ISO/IEC 18000and ISO/IEC 29167 use on-chip cryptography methods for untraceability, tag and reader authentication, and over-the-air privacy. ISO/IEC 20248 specifies a digital signature data structure for RFID and barcodes providing data, source and read method authenticity. This work is done within ISO/IEC JTC 1/SC 31 Automatic identification and data capture techniques. Tags can also be used in shops to expedite checkout, and to prevent theft by customers and employees

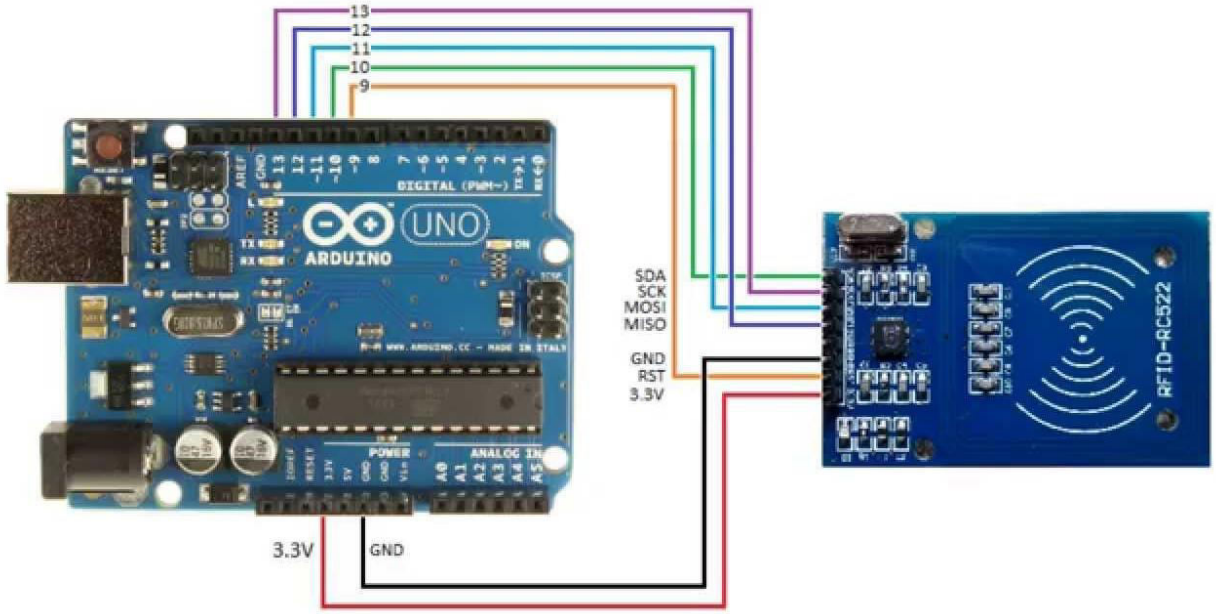


Fig 8.3 RFID - ARDUINO pin configuration

8.2.1 RFID TAGS

RFID tags serve the purpose of unique product identification since each tag has a unique hexadecimal code which serves the purpose of product information identifier.

Fig 8.4 RFID tag

When a customer places a product into the basket then the RFID reader recognizes the product and bills the product to the particular customer's cart. If the customer wishes to replace the product then the RFID reader recognizes that the product has been removed from the basket through the same sensor and deletes the product from the cart. This RFID reader is mounted on the cart and changes the state of the tag as active and passive. When the customer places the item inside the cart the state changes as passive and when he replace the product back into the stands it changes as active. The condition of active and passive states of the product must be relied promptly to the customer's cart and the central system. These states decide whether a product is in the stands or in a particular customer's cart.

8.3 COMMUNICATION MEDIUM

NFC suffers from the drawback of transmitting information only short distances, therefore a communication medium must be used for relying information to and fro from the central system. This communication medium must have the ability to communicate messages over a distance of an average of 10,000 sq.ft. Such communication must be fast and must sync in exact order with the central database.

8.4 WAMP SERVER

Wamp server comprising of a variety os support softwares which include Apache web server, OpenSSL for SSL support, MySQL database and PHP programming language. This serves as the focal point for synchronous communication among customer's android phones.

8.5 TWEDGE

Using Twedge we can connect devices with any application, document or database. TWedge automatically collects data from bar-code readers, gauges, electronic scales, RFID controllers without having to modify the target applications. The QR-code from the

customer's android phone is scanned using twedge which is then sent to the central database for logging. Twedge is used because of its Android compatibility and ease of use.

8.6 PHP

The connection between the database and the android application is done using PHP. When the customer logs into the system the scanned QR-code is sent from the Twedge platform is transferred to the database. The unique QR-code which matches the customer's identity is recognized and updated through the PHP connection which has been established.

CHAPTER 9

IMPLEMENTATION

9.1 ANDROID APP LAYOUT

The customers can have their E-Cart viewed through the provision of an Android Mobile Application which enhances their hassle free shopping. This makes it possible for customers to make payments for their purchased products through various payment gateways online. The android phone will be automatically connected to the shop's WIFI when the customer logs in. The customers have a special way of logging on to their profile via the Android Application. After they have typed the username and password, a unique QR code will be displayed onto their screen. The customer then needs to scan the QR code with the shop's QR code reader for successful authentication.

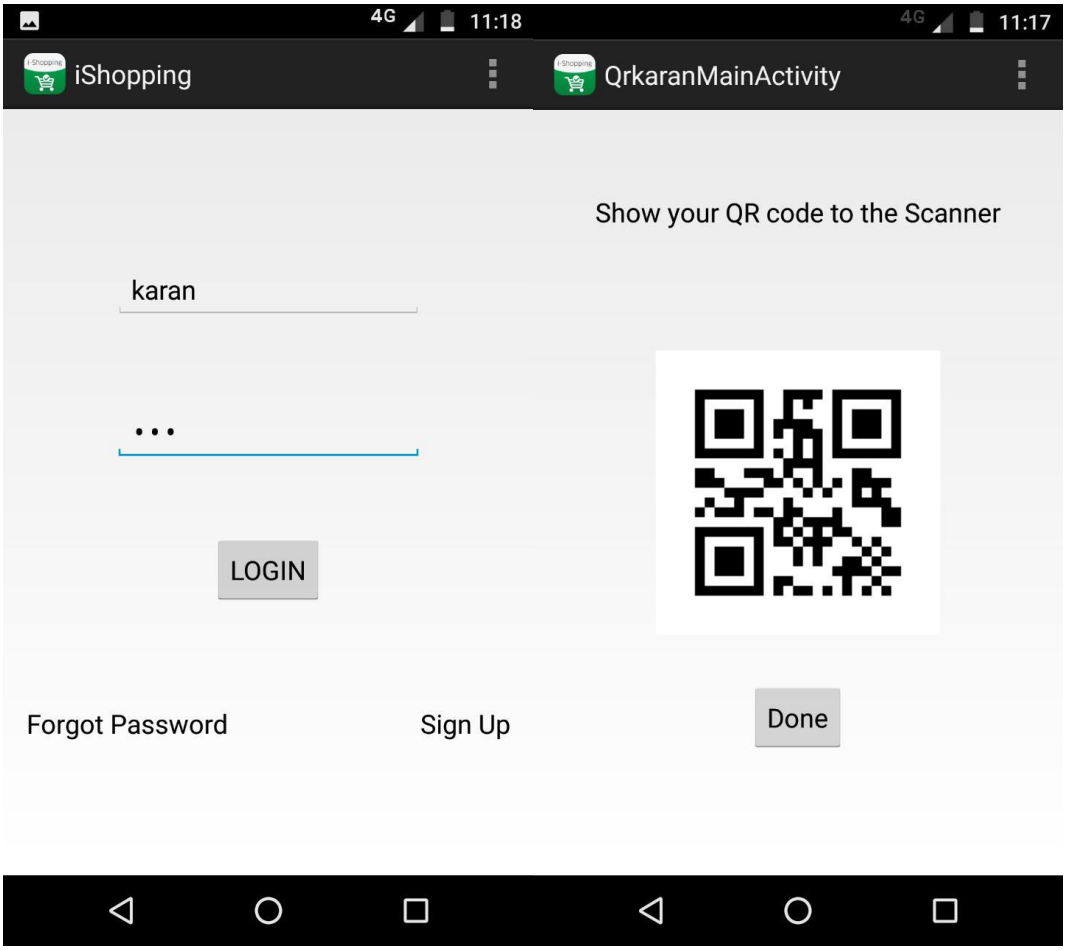


Fig 9.1 Login Page, QR-Code scan Page

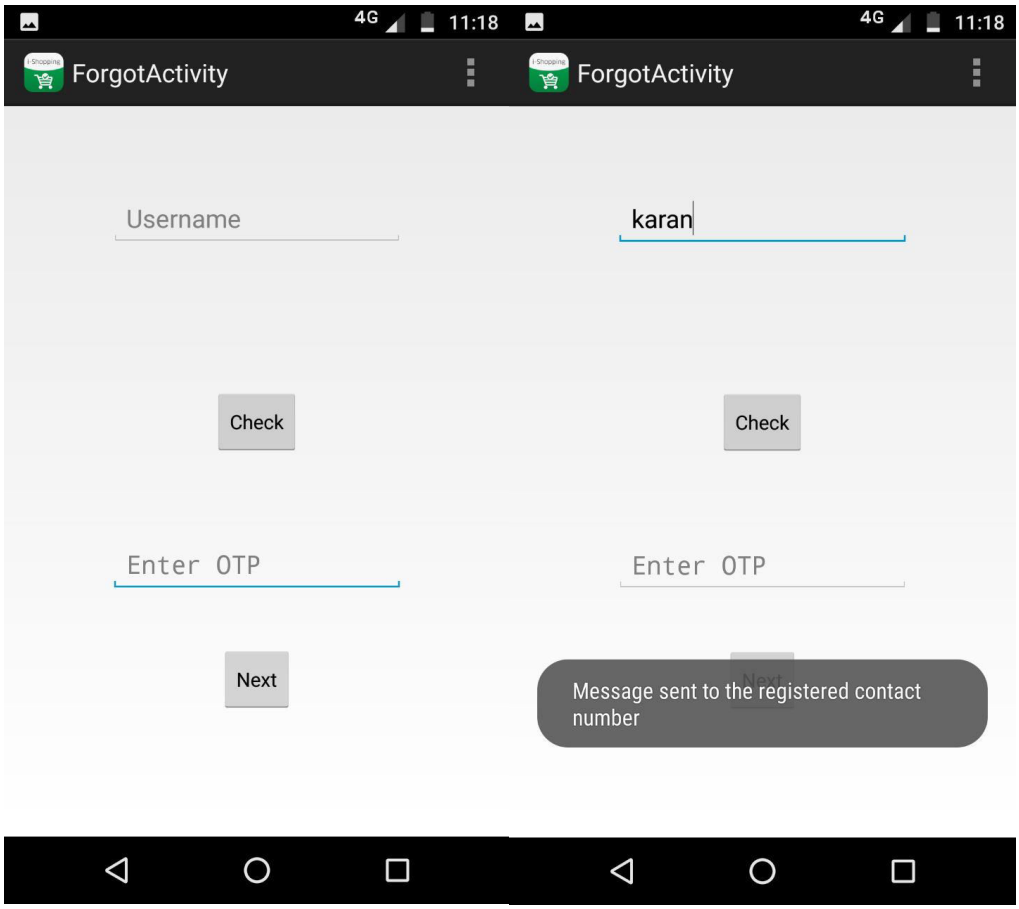
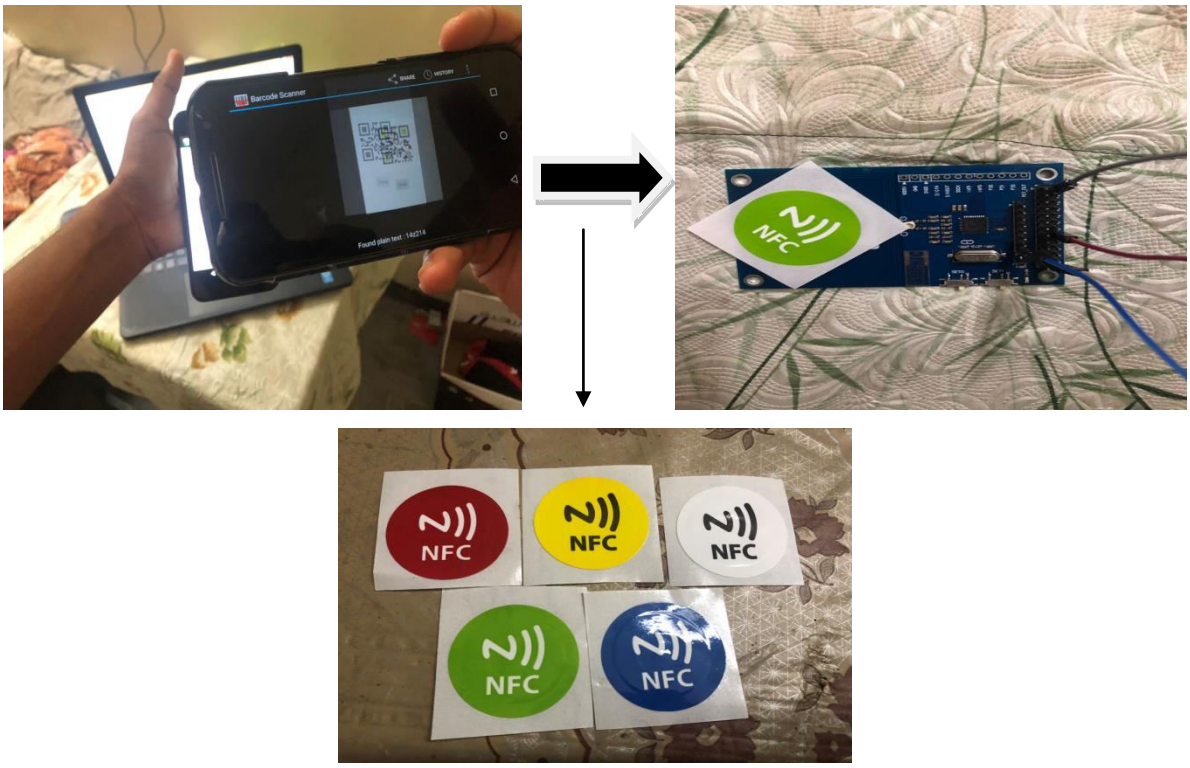


Fig 9.2 Password Update Page, User Name Authentication Page

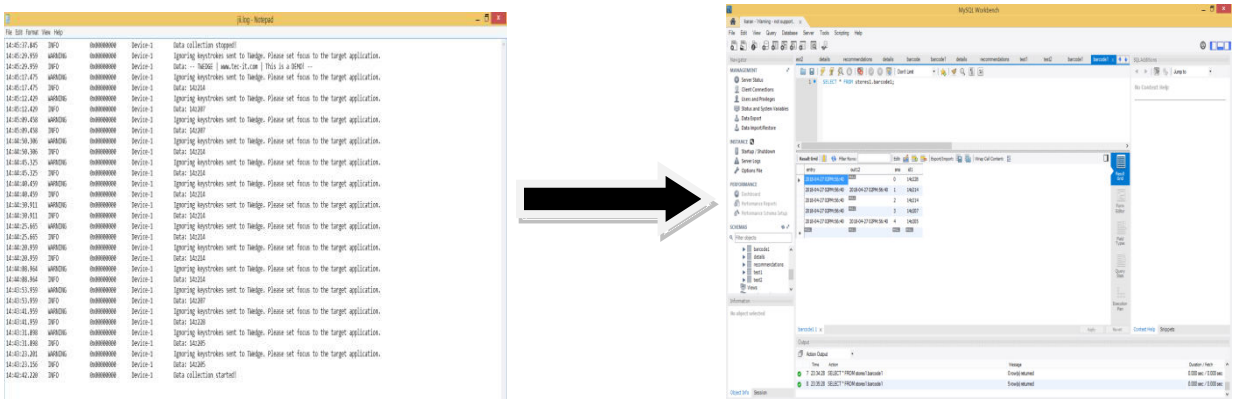
Customer logs in through QR code

Interaction between customers mobile and store's cart through NFC



Portable NFC stickers for non-NFC mobiles

Fig 9.3 User Interaction



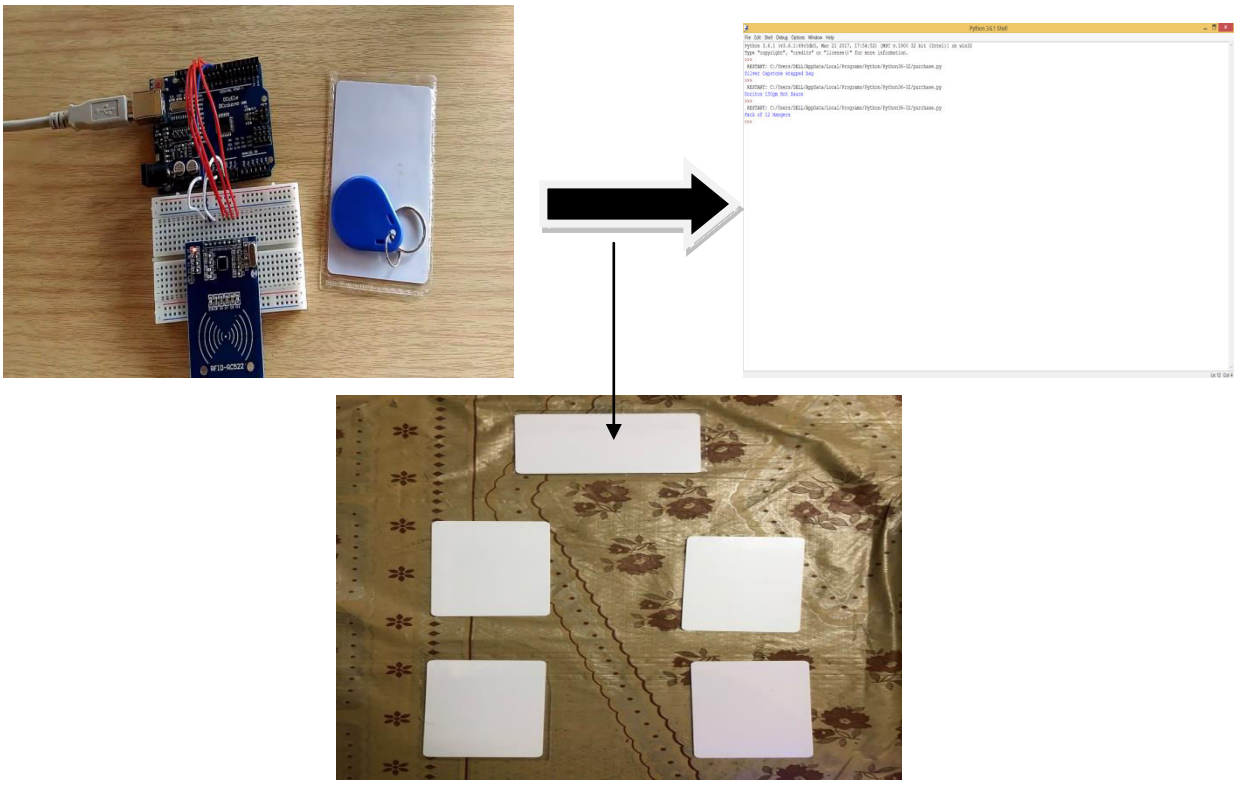
TWedge login portal

Update process of login info to MySQL database

Fig 9.4 System storage

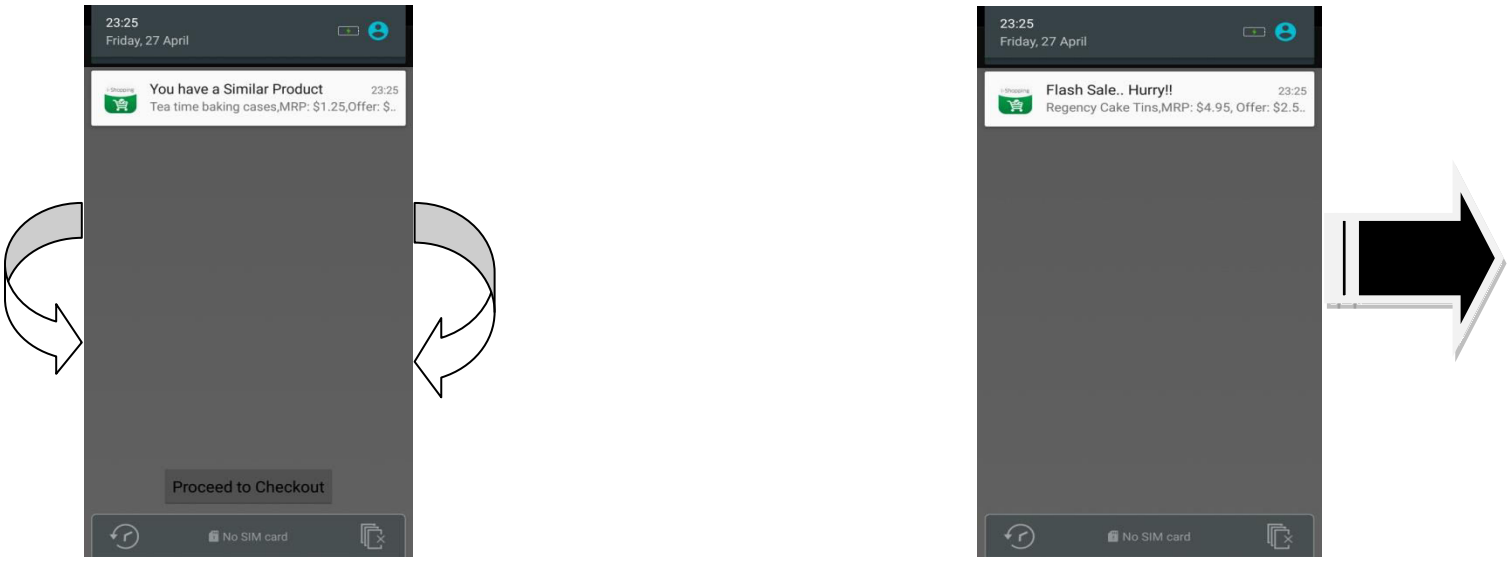
Product purchase through RFID identifiers

Purchase product display



RFID tags embedded with store's products

Fig 9.5 Product purchase



Instore Outstore

Fig 9.6 Recommendations

CHAPTER 10

CONCLUSION AND FUTURE WORK

Shopping can be made user friendly if all the unnecessary time lags at various spots can be avoided and the products recommended according to the user's ideology. Also, if a customer can purchase something without having to wait for it then the system would drive massive changes in the entire shopping industry. A purchase requires only one kind of interaction between the buyer and the product itself, no kind of external interaction is required. So we believe in delivering such a solution to the retailing industry. Future extension of the system would be to implement the system with AI algorithms which would automatically recognize your future shopping trends and make product suggestions accordingly.

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