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Design and Implementation an RFID Customer Shopping Behaviour Mining System

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ABSTRACT: Shopping behavior data is of great an importance in understanding the effectiveness of marketing and merchandising campaigns. Online clothing stores are capable of the capturing customer shopping behavior by analyzing the click streams and customer shopping carts. Retailers within physical clothing stores, however, still lack effective methods to comprehensively identify shopping behaviors. In this study, we show that backscatter signals of passive RFID tags can be exploited to detect and record how customers browse stores, which garments they pay attention to, and which garments they usually pair up. The intuition is that phase readings of tags attached to items will demonstrate distinct yet stable patterns in a time-series when customers look at, pick out, or turn over desired items. We design Shop Miner, a framework that harnesses these unique spatial-temporal correlations of time-series phase readings to detect comprehensive shopping behaviors. We have implemented a prototype of Shop Miner with a COTS RFID reader and four antennas, and tested its effectiveness in two typical indoor environments. Empirical studies from two-week shopping-like data show that Shop Miner is able to identify customer shopping behaviors with high accuracy and low overhead, and is robust to interference.

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I.   INTRODUCTION

The India Retail Industry is one of the fastest growing industries the employment. The vast middle class and its almost untapped retail industry are the key attractive forces forthe global retail giants wanting to enter into newer markets. A large young working population is median age of 24 years, nuclear families in urban areas, along with increasing working women population and emerging opportunities in the services sector are going to be key factors in the growth of the organized retail sector in India. The growth pattern in the organized retailing and the consumption made by the Indian population will follow a rising graph helping the newer businessmen to enter the Indian Retail Industry.

Although many Indian industrial giants entered in a big way in retail sector, but all of them have not yet tasted success because of the heavy initial investments that are required to breakeven with other companies, differences in customer taste and behaviours compared to western countries due to cultural differences and are unable to compete with existing players. More over the total concept or the idea of shopping has undergone a sea change in the recent years. Thanks to the internet and rise of smart phones, because of which consumer spending habits have changed; they now demand an Omni-channel approach to which many established retailers up, as the walls shrouding the industry in mystique have fallen with the emergence of digital age.

Being able to listen to and react upon consumer interest and sentiment are major pain points for large retailers.

CHALLENGES IN RETAIL SECTOR

Largest company (Wal-Mart) is a retail company. Over fifty of the fortune 500 companies are retail companies. Twenty five of the Asian top 200 companies are retail companies. Retail sector includes small shops like discount stores, malls, department stores, specific product-showrooms, convenience stores, supermarkets and many more. Some of the business challenges in retail sector are to be first considered to understand the problem and find a larger solution (Retail sector - Top 10 risks 2013).

Demand depends on Economy - Economic factors, including personal income, consumer confidence, job growth, availability of easy fund, credit schemes and interest rates, can greatly affect consumer spending in the retail sector. A recession implies a fall in real GDP; it is a period of negative economic growth. Recessions are primarily caused by fall in aggregate demand. This demand side shock could be due to the several factors, such as financial crisis, rise in interest rates or fall in asset prices (like houses). During recessionary periods, retail sales growth slows down drastically and even decline to a bare minimum that cannot be sustained by an industry for a longer period. Retail spending rises rapidly during periods of strong economic growth, as consumers spend a greater share of income and increase their personal debt. The recession or economic

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slowdown reduces purchasing power of consumers and so they tighten their belts in many ways by cutting their expenditure.

Even after recession, the retail market does not pick up easily. Customers lose confidence in the economy after recession and they delay or postpone purchasing cars, clothes, watches, jewelleries and so on. Decrease in consumer spending causes businessmen to lay off workers or even close down their unviable outlets. Rising interest rates affect consumer credit and consumer ability to finance large retail purchases such as cars, costly watches, jewelleries and so on.

Competitiveness

Competitiveness increases as more companies enter the retail market and spread their outlets in many countries and the awareness of cultural difference is vital for its success. Cultural competence helps to understand how and why people think, act and buy things in a different way and they do differ from season to season or quarter to quarter. In many retail segments, large companies dominate and hold the majority of the market even retailers in fragmented markets must compete with mass merchandisers and warehouse clubs that offer smaller selection of comparable merchandise at low prices.

INTRODUCTION OF RFID

The objective of this study is to unfold the important aspects of the Radio FrequencyIdentification technology which would help in the improved understanding of the rest of the Thesis. Radio Frequency Identification (RFID) is an automated identification technology Possessing greater identification capabilities than bar codes. Worldwide, the RFID technology acts as a base in automated data collection, identification and analysis of dynamic systems. RFID has found its importance in wide range of markets including livestock identification and Automated Vehicle Identification (AVI) systems because of its capability to track moving Objects. Barcode labels could not survive in certain manufacturing environments where RFID systems are found more robust and reliable than barcode labels in certain manufacturing environment systems.

Such examples include but are not limited to the penetration of RFID technology into the bodies of consumers and tagging of mothers with their new borne babies which forbid a later mismatching.

In everyday life, the most common form an electronic data-carrying device if often a Smartcard which is probably based upon the contact field. But, this kind of contact oriented card is normally impractical and less flexible to use. On the contrary, if a we think of contactless

Card with contactless data transferring capabilities, it is would be far more flexible. This communication happens the between the data carrying device and its reader. Now, this situation may further appear as ideal if it so happens that the power for the data carrying device comes from the reader by making use of the contactless technology. Because of this specific kind of power transferring and data is carrying procedures, the contactless automatic identification systems are termed as Radio frequency Identification Systems. Presently a huge number of companies are actively involved in the development and sales of RFID systems which clearly indicates that this market must be taken seriously. Moreover, in recent years, RFID has grown into an interdisciplinary independent filed which hardly fits in traditional pigeon holes. This is due to the fact that this contactless automatic identification technology uses elements of diverse areas like cryptography, HF technology, telecommunications, semiconductors, data protection and many more.

AUTOMATIC IDENTIFICATION (AUTOID)

This section of the thesis primarily revolves around the umbrella term AutoID under which RFID rests. The term AutoID refers to the host of methods which automatically identify objects .This is typically a process of gathering data and then feeding it into computer systems in abeeline. Technologies typically considered as part of AutoID include barcodes, smart cards,OCR and RFID. Barcode can be considered as one of the most widely recognized AutoID systems. To capture data in a fashion that increases operation efficiency and reduces data entry errors are primarily the aims of most AutoID systems. As per the current scenario, in which a number of Auto ID technologies are gaining acceptance, industries are offered a choice to adopt more efficient and accurate standard. This thesis focuses on the RFID (Radio Frequency Identification) technology which is primed to instigate the identification of objects and become the system of adoption in the industries.

Falling into one of the prime aims of Auto-ID Center that will enable widespread adoption is cost to the end user. The Auto-ID Center is figuring out with its partners for making RFID a feasible alternative for barcodes. This is taken care of by facilitating the design and production of RFID tags which cost pennies when manufactured in large numbers. At the same time they are also following their plan to develop open standards for RFID readers.

The Auto-ID Center is playing a crucial role to help establish standards and promote the adoption of RFID. Key members of the Auto-ID Center backing RFID include Wal-Mart, P&G and Gillette. When and if RFID technology does become the de facto in automatic identification, the Auto-ID center will have played a substantial role. The future of a

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tagged world may largely be attributed to this community. Perhaps the greatest influence the Auto-ID Center has in the universe of RFID is the design of EPC (Electronic Product Code).

WHAT IS RFID

The term **RFID** stands for **Radio Frequency Identification**. Radiostands for the invocation of wireless transmission and propagation of information or data. For operating RFID devices, **Frequency** defines spectrum, may be low, high, ultra high and microwave, each with distinguishing characteristics.

Identification relates to identify the items with help of various codes present in a data carrier (memory-based) and available via radio frequency reading. The RFID is term which is used for any device that can be sensed or detected from a distance with few problems of obstruction. The invention of RFID term lies in the origin tags that reflect or retransmit a radio-frequency signal. RFID makes use of radio frequencies to communicate between two its components namely RFID tag and the RFID reader. The RFID system can be broadly categorized according to physical components of frequency and data. Physical components of RFID system include, but are not limited to, the following: numerous RFID tags and RFID readers and Computers. The factors associated with RFID tags are the kind of power source its has, the environment in which it operates, the antenna on the tag for communication with reader, it's a corresponding standard, memory, logic applied on the chip and application methods on the tag.

The RFID tag refers to tiny radio device also known as radio barcode, transponder or smart label. This tag is comprised of the simple silicon microchip which is attached to a small flat antenna and mounted on a substrate.

The entire device can be encapsulated in various materials dependent upon its intended usage. The finished RFID tag can be attached to an object, typically an item, box or pallet. This tag can be read remotely to ascertain position, identity or state of an item. The application methods of an RFID tag may take forms attached, removable, embedded or conveyed. Further, the RFID tagsdepend upon the power source which may be battery in case of active-tags and an RFID reader in case of passive tags.

II.   LITERATURE REVIEW

Berenyi et al (2008) discussed the customer frequent walks in the RFID equipped retail out. They described that the sequences are extracted by using prefix span pattern growth algorithm but they did not address the behaviour of customer based on frequent walking patterns. They did not focus on the RFID data redundancy generated in the process.

Nakahara et al (2010) presented the work extracting sequential patterns using LCM sequence. They extracted sequences to identify the prime customers based on in-store movements of the customers and purchasing behaviour. They constructed a decision tree model using the extracted patterns to determine prime customers in-store movements. They concentrated only on classification of customers into high-value purchasing customers (prime customers) and other customers (general customers). But they did not address the extracting the customer purchase behaviour based on the in-store movements of customer. They did not address how to handle data redundancy in the customer movement path data. The volume of path data is a very large, since the position of a cart is updated every second. This leaves large volume of duplicate readings in RFID data.

Most of the existing methods suffer from data redundancy caused by deployment of multiple RFID Readers and extracting customer behaviour efficiently based on the customers frequent walking path pattern. This poses challenges for data management. The issues related to RFID data filtering and retrieving the frequent customer movement in the retail outlet is one of the motivations for the research. The research work focuses on elimination of RFID data redundancy and path pattern discovery from RFID-collected consumer shopping path data.

Brian L. Dos Santos and Lars S. Smith (2008) pointed out that Managing supply chains effectively is becoming increasingly challenging as outsourcing and off shoring increases, and globalization makes marketplaces more competitive. RFID can benefit retailers and upstream supply chain members.

It can help reduce counterfeiting it can improve on-shelf availability, customer service, inventory management, downstream forecasting, and warehouse and back room operations. Lee Revere, Ken Black, and FaizaZalila (2010) pointed that Technologies increase efficiency, enhance quality, and improve patient safety in healthcare organizations. RFIDs can be integrated into all areas of internal patient supply chain, serving as clearinghouses of information. By providing timely information on the patients, processes, and equipment, RFIDs can save time and reduce costs while simultaneously improving quality and patient safety.

Heim, Wentworth, and Peng (2010) noted that RFID service applications offer both benefits and drawbacks for customers. These are important inputs to managerial decisions regarding how RFID might be usedto design or enhance service operations. Useful decision-making tools and frameworks may help managers to prioritize between potential RFID applications for service process improvement, evaluate the feasibility and ROI for

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each application, and make appropriate and timely Decisions.

III. EXISTING SYSTEM

In this project, Backscatter signals of passive RFID tags can be exploited to detect and record how customers browse stores, which garments they pay attention to, and which garments they usually pair up. The intuition is that phase readings of tags attached to items will demonstrate distinct yet stable patterns in a time-series when customers look at, pick out, or turn over desired items. We design Shop Miner, a framework that harnesses these unique spatial-temporal correlations of time-series phase readings to detect comprehensive shopping behaviors. We have implemented a prototype of ShopMiner with a COTS RFID reader and four antennas, and tested its effectiveness in two typical indoor environments. Empirical studies from two-week shopping-like data show that ShopMiner is able to identify customer shopping behaviors with high accuracy and low overhead, and is robust to interference.

DISADVANTAGES

- RFID systems are often more expensive than barcode systems.
- RFID Technology is harder to understand
- Can be (debatably) less reliable
- RFID tags are usually larger than barcode labels
- Tags are application specific. No one tag fits all
- Possibility of unauthorized reading of passports and credit cards.
- More than on tag responds at the same time.

IV. PROPOSED SYSTEM

In proposed system, even more accurate shopping behavior data could benefit retailers to discover popular categories, hot items, and correlated pairs for better trading strategies and tie-in promotions. We are examining the accuracy and robustness of ShopMiner in various testing scenarios. Results show that ShopMiner achieves high accuracy in the customer shopping behavior identification and holds potential for practical deployment.

ADVANTAGES

- Wal-Mart is banking on this technology to manage inventory more efficiently, reduce numbers of data entry errors, and lower human labour costs in a distribution center
- The retailing major is intending to use the data to keep track when stock is running low on shelves or when items have been stolen. The other advantages expected are:
- The movement of inventory can be tracked
- Goods can be received and shipped faster

- Ease of predicting product demand
- Shoppers can save time
- Out of stock situations can be avoided
- Shoppers get a better deal as system becomes more efficient
- The right products are available at the right stores at the right time
- Boost sales

V. CONCLUSION

In this paper, we present the design, implementation and evaluation of Shop Miner, a RFID-based customer shopping behavior mining system works in physical clothing stores. By attaching each clothing item with a RFID tag, Shop Miner could "see" and detect how customers browse the stores, which category of items they show interest, and which items they match with. Such comprehensive shopping behavior data could benefit retailers in capturing customers' flavors, testing new arrivals, and further optimizing their commercial strategies. We examine the accuracy and robustness of Shop Miner in various testing scenarios. The preliminary result shows that Shop Miner could achieve high accuracy and efficiency in customer shopping behavior identification, hence hold potential for practical deployment.

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