A Detailed Survey on Various Tracking Methods Using RFID

S. Arivarasi [#1] & S. Krishna Anand[*2]
Computer Science & Engineering, School of Computing,
SASTRA University, Tirumalaisamudram, Thanjavur-613401,Tamilnadu, India.
[1]arivarasiarivu@gmail.com
* Computer Science & Engineering, School of Computing,
SASTRA University, Tirumalaisamudram, Thanjavur-613401,Tamilnadu, India.
[2]skanand86@gmail.com

***Abstract*- RFID, a wide range of technology is replaced instead of barcode. When multiple RFID readers find a single RFID tag at same time, duplicates occur. The main objective is to eliminate duplicates in RFID data. Designing an exact duplicate elimination method is very difficult. This paper presented a detailed analysis of tracking, monitoring, managing and filtering mechanisms for RFID data.**

Keywords: RFID, EPC, Tracking, Monitoring and Duplicate elimination.

I. INTRODUCTION

Over the past several years, RFID (Radio Frequency Identification) has replaced the use of Barcode. RFID technology is used for reducing costs and to improve service levels. It is used in many applications such as health care, military, and department store, medical, business and other related applications. An RFID system comprises of RF tags, host computers and RFID readers with antennas which are recognized by the readers. An RFID tag can be uniquely identified by its tag ID. It can be stored in its memory. A persistent numbering schema namely EPC (Electronic Product Code) is used to the unique product IDs. EPC contains tag identifier, location and time. RFID has been used for tracking and monitoring the identification of objects, persons, products, traffic and aspects related to animals. Duplicates can be eliminated by using RFID.

II.LITERATURE SURVEY

C. Bornhovd et al. designed SAP Auto id infrastructure to check the quality of the product in the year 2004. SAP auto id infrastructure could be used to locate damages in the product if any. In the same year, RFID Layered architecture was successfully incorporated by S.S. Chawathe. In the year 2005, F. Wang and P. Liu used RFID to identify the products that were lost during transaction between stores. This identification takes place through EPC code. B. Carbunar suggested two algorithms namely RCA (Reader Collision Avoidance) and RRE (Redundant Reader Elimination) for eliminating redundancy in 2005. However, it has been observed that there has been considerable amount of noise apart from the presence of duplicates.

To overcome the problems cited, Y.Bai et al. proposed RFID data filtering algorithms for noise removal and duplicate elimination. Baseline-denoise, Lazy-denoise and Eager denoise are used for noise removal. Baseline merge and Hash merge have been used for duplicate elimination in 2006. H. Gonzalez et al. proposed RFID warehousing model for answering large number of queries in 2006. Adaptive cleaning method called SMURF algorithm was proposed by S.R. Jeffery et al. in 2006. By proper usage of data cleaning and redundancy at readers level, problems such as imperfect data and data redundancy can be solved as suggested by Roozbeh Derakhshan et al. in 2007. Pavel Vrba et al in 2008 discovered that two products of the same item with different EPC codes can be tracked and monitored.

Yu-Ju Tu et al. proposed three algorithms to find misplaced objects and theft objects in the year 2008. C.H. Lee et al. proposed query processing schema for supply chain management in 2008. Athanasios S. Voulodimos et al. tracked the location and characterstics of animals by inserting three RFID tags namely Boluses, injectable glass tags and Ear tags in 2010. Chun–Hee Lee and Chin-Wan Chung proposed three algorithms namely bloom filter, time bloom filter and time interval bloom filter for duplicate elimination in RFID data streams in 2011.

III.STUDIES ON RFID

A.Business Process Using Sap's Auto-Id Infrastucture

C. Bornhovd et al. designed SAP Auto id infrastructure to check the quality of the product [1] in 2004. RFID technology is used to track the deliveries from distribution centre to destination. Metadata and rules are fed directly to business processes which run either on SAP or non-SAP systems. The main objective is to deliver the products without any damage. Hence, the products are tagged and assembled. Products packed into pallet are also recorded. The recorded information is sent to the Auto-ID node that passes the information through a

reader. The information is separated from the reader and the resultant data is collected and sent to the Auto-ID Node. At the destination store, incoming goods are read and identified. The products are scanned to determine its availability. The main drawback in this approach is to identify customer conduct and possibility to track people. Technical mechanisms are required to encode effective tag and sensor information and data security. Tags are also disabled at predefined stages in a retail chain.

B. Handling RFID Data

S.S. Chawathe et al. discussed RFID layered architecture [2] in 2004. RFID data manages aircraft maintenance that includes baggage handling and laboratory procedures. It is also used to monitor the patient's health which was in abnormal condition. RFID data contains a layered architecture. RFID tags are present in the lower layer. The following layer comprises of tag readers. RFID Air Interface is present amongst those two layers, which indicate the subordinate details such as anti-collision techniques. The next layer accommodates a stream of tuples that is considered as data. The third layer includes a mapping technique that is eligible at the application level. The fourth layer deals with higher level services. It can be inferred from the application that inferences are more relevant at higher levels. Besides, contradicting tags can also be identified. RFID infrastructure data propagation process needs online methods. In place of RFID infrastructure, warehousing infrastructure can also be used. In order to incorporate the same, central warehouse aggregating data is used for grouping and aggregation function. However, RFID system allows effective transformation. RFID tags and readers use different capabilities for effective cleaning and filtering.

C.Time Management RFID Data

As inferred from the literature survey, F. Wang et al. proposed the mechanism to identify products lost during transactions [3] in 2005. The product or material in the provider store should reach the department store through the transport mode without any loss of product between routes of two locations. Each product is tagged with EPC (Electronic Product Code). EPC is a recognition system for generally identifying personal products. The product with EPC code is packed into pallet at the provider storage. The product with the pallet is glanced over by an RFID reviewer. At the provider loading area, pallets are filled into the truck and both the pallet and truck are glanced over by another RFID reviewer. The truck then goes to a department store through a fixed route. At the discharge of the department store, all pallets and products are taken out from motor truck. All products, truck, pallet are glanced over by another RFID reviewer and products are bought into the store. When the product is bought by the clients, they are glanced by another reviewer. Within the fixed route, if any product in the pallet is missed, it is chased and supervised by RFID. The designed system by F. Wang et al. considers two aspects. One aspect deals with time while the other deals with location. The usage of EPC plays a vital role in handling this aspect. It has been found that the involved mechanism provides reasonable recovery rates.

D.Repetitive Elimination In RFID Systems

B. Carbunar et al. discussed several algorithms for redundant reader elimination [4] in 2005. RFID addresses two major issues with redundant reader elimination. One issue deals with identification of redundant RFID readers and tags. The complexity of these problems arises from collision finding mechanisms. Localized, randomized and distributed solutions like RCA (Reader Collision Avoidance) and RRE (Redundant Reader Elimination) have been proposed to address the issue. Reader Collision Avoidance is used to avoid the collision of readers. RCA uses tag collision to avoid the reading of RFID reader at the same time. However, the battery lifetime of RFID reader network is reasonably short. Steps need to be taken to enhance this time. The main purpose of RRE is to determine highest count of redundant readers which can be turned off. The three kinds of redundant reader problems have been described by B. Carbunar. The first problem deals with identification of the extent of coverage which is defined in terms of distinct points only. Aspects dealing with location information rely on sensor network. Despite the fact that the resources are limited for RFID tags, the operation performed reasonably efficiently. RCA algorithm has been used to avoid reader collisions. It also permits RFID readers to exactly identify the tags. RFID reader identify the entire RFID tags in the questioning sector, but simultaneous reply from RFID tags of reader is impossible to create exact decoding of signal. This in turn could lead to tag collision.

E.Enhancing RFID Data Using Filtering

Bai et al. proposed RFID Data Filtering schema for noise removal and duplicate elimination [5] in 2006. The RFID Data Filtering consists of three type's namely false negative, false positive and Duplicate Readings. False negative reading occurs due to collisions in radio frequencies. These collisions in turn prevent proper identification of tags. On some occasions, a false positive reading can lead to detection of additional unwanted information. Duplicate readings are generated when several tags are read by the reader for a long period of time. Reading precision is increased by reading the tag with same electronic processor codes attached to an object several times. Reading the same tag several times lead to generation of duplicates. Denoising works based on three algorithms namely Baseline denoise, Lazy denoise and Eager denoise. In Baseline denoising algorithm, the output generated first is alone considered. All other output readings are placed in a window

buffer. But the problem in Baseline denoising algorithm is that the accepted output is out of order. Lazy denoising algorithm works by scanning the window buffer for non noise readings. The order of output reading is solved by baseline algorithm. Lazy denoising algorithm determines whether the output reading is noise or non–noise. If it is non-noise, it is removed from the buffer window. It uses a queuing concept of First In First Out. This allows the readings to be arranged in proper order. The major drawback in this algorithm is the presents of a significant amount of delay. Eager denoising algorithm operates by keeping the first noise reading in window. Invariant reading is kept at the ends. The valid reading obtained before the generation of first noise is considered as output. Baselines merge and Hash merge algorithms have been used for duplicate elimination.

F.Storing and Examining Massive RFID Data Sets

H. Gonzalez et al. analyze a warehouse model [6] in 2006. To answer a number of queries, a RFID Data warehouse model is used. RFID Data repository model contracts and combined RFID data in a coordinated manner. This architecture constitutes of a fact table and an information table. A fact table named stay consists of RFID records which have been cleaned. An information table named info accommodates path-independent information for record. By using be process of data compression, data records are grouped, merged and compressed. Merging helps in reducing the data size of the records. A data structure namely RFID Cuboid is used to store the combined data in RFID Data repository. The three tables in RFID cuboid are aggregated at a high abstraction level which includes Info, Stay and Map. The information table consists of path-independent attributes. Each attribute is connected with a concept hierarchy. The Stay table reduces the size of RFID repository by compressing the items present in a single location. The map table permits query processing to connect the stages of a single path. Thus, RFID Data warehouse is differentiated from the traditional warehouse. The RFID cuboids are more complex than regular cuboids as a result of data aggregation.

G.Adaptive Cleansing For RFID Data Streams

S.R. Jeffery et al. introduced an adaptive smoothing filter namely statistical smoothing for Unreliable RFID data (SMURF) to clean the unprocessed RFID data streams [7] in 2006. Differentiating the dropped down readings of periods and periods that were noted during the movement of tag is a major dispute in an adaptive smoothing filter scheme. SMURF solves this dispute by using statistical sampling-based approach. It processes the RFID data using cleaning, filtering and spatial processing. The benefits of practicing SMURF include ease in configuration and maintenance. Irrespective of the deployment environment, reliable RFID data is created. The components used in RFID installation include reader, tags and antennae. A reader generates list of ID's by communicating with tags. Antennae are used for communication between reader and tags. The chief cleaning mechanisms are per-tag cleaning and multi-tag cleaning. Single tag reading is cleansed in per tag cleaning where as large collection of tags is processed in multi-tag cleaning.

H.Study on RFID Data Management

Roozbeh Derakhshan et al. discussed a couple of problems associated with RFID data. Enough emphasis has been given to problems associated with imperfect data and its redundancies [8][4] in 2007. RFID technology is used to reduce costs, improve service levels and to identify specific product related information. It works by storing a serial number, which identifies a person or product. RFID is used predominantly to a large extent for identifying the location and also in wireless connections. The major challenge in RFID is their huge fallible data, which needs to be clean. Data redundancy occurs when more than one reader sends simultaneous signals to the product items. To overcome problems associated with data, a good amount of research has been carried out. Suggestions for a feasible solution include tagging of objects followed by cleaning of the same before passing it to the next layer. Other suggestions include extensible data processing which could in turn facilitate data cleaning. However, data redundancy issues continue to pose problems. To avoid data redundancy, RRE (Redundancy at readers' level) algorithm is used. Initially, it finds the group of RFID tags that is placed in location of reader and then tag count is written on the tags which are covered. Finally, covered tag which is unlocked by the reader is announced as needed. But RRE algorithm is not suitable for supply chain as reader position order could be changed.

I. RFID in Industrial Application

Pavel Vrba et al. discussed tracked and monitored identification of the product [9] in 2008. A large spread technology called Barcode is used for marking and placing products or objects. However, it poses many restrictions. Some of the restrictions include placing a product between reader, label and choice of a proper barcode. One of the effective methods to use RFID from bar code is in finding multiple products simulation as they enter through a reader, i.e. presence of all products in closed box can be checked without opening. Moreover, two products of same type with different ID is easy to track. It also observes the location of each labeled product. EPC code is integrated into RFID tag memory, which accommodates details about manufacturing and type of product. Object Name service is used to transform EPC into Universal Resource Locator. By using this, more information about the product can be found.

J. RFID in Healthcare Application

Yu-Ju Tu et al. suggested several algorithms to decrease false positive reading and false negative reading that were used for object identification and tracking patient details [10] in 2009. Pervasive healthcare delivers its service to anyone regardless of time, location and restriction. Intelligent information systems technology uses multiple layers to deliver results smoothly. CDSS (Clinical decision support system) is used to aid instruction in medicines, clinical labs, clinical investigation, and medical care settings. HIS (Healthcare Information System) is used to review treatment and dosage faults. CDSS transforms existing healthcare system. Such systems reduce fault rates and improve treatment. Asset management is necessary to identity and chase mobile objects. Inventory management reduces billing errors, misplaced articles and theft. RFID tags are used to identify an object location for various scenarios. False positive and false negative readings also occurred when a signal generated by an RFID tag is hindered by an object. To reduce false positive and false negative readings, an algorithm named base case is used. In this algorithm, the presence or lack of an RFID tag in the field of reader is identified. It can be done through small modifications to input data analysis.

K. RFID: Query Processing and Storage Schema in Supply Chain Management

C.H. Lee et al. proposed the methodology for processing queries and tracking queries in supply chain management [11] in 2008. In order to improve efficiency in supply chain management, query processing scheme has been proposed. By using query templates, supply chain can be analyzed. The path encoding schema is used to encode flow information. It devises a storage schema to process the queries efficiently. RFID data is stored in central server. It can also be stored in a relational table. It includes the fields such as START TIME, LOC, TAG ID and END TIME. Here, TAG ID denotes tag identifier, while LOC denotes location. START TIME represents the time when tag entered the location, END TIME denotes the time when tag gets out from the location. RFID data can also be stored efficiently in Stay Table (START TIME, LOC, TAG ID, COUNT and END TIME) which are used for minimizing the table size. It focuses on encoding. It uses the properties of prime numbers for encoding nodes between paths. Paths can be retrieved efficiently by checking the path condition in the query. Encoding scheme works based on Arithmetic and Chinese Remainder Theorem. Time information is stored regarding tag movements. By the use of region numbering scheme, time information can be retrieved. Three levels of query templates are used. They are tracking, path oriented retrieval and path oriented aggregate query. Initially, tracking query is used to trace the tag for tag identifier. Path oriented retrieval query is then used to contain a path condition and an information condition. Finally, Path oriented aggregate query involves aggregate, path conditions and information conditions.

L.Discovering A Location Of Animal Using RFID:

Athanasios S. Voulodimos et al. discussed several methods to analyze animal identification [12] in 2010. FARMA platform is used with RFID technology. This technology could help in assisting veterinary doctors in identifying presence of a disease in animals. RFID tag numbers contain records of animal data. It has been observed that the location of animals could be easily tracked in every stage of its life even without the use of database tables. Three types of tags are used for animal identification. Boluses are capsules comprising RF transponder, which are kept in stomachs of ruminants. Ear notching is used to identify swine, placed in ears. To avoid staining, inked numbers are injected permanently in skin. By using FARMA, enormous amount of data regarding animal data is managed. Animal identification parameters such as identity and property are stored. FARMA platform controls animal movement parameters. They are ingress and Egress. Ingress defines all new animals enrolling the farm and egress defines animals exiting the farm. Health parameters of an animal including vaccination system, medication and controlling infectious diseases are accumulated to provide useful information to veterinarians and owners. If the animal is found by using FARMA platform, data about identity can be identified. This data in turn could be used in dealing with animals.

M.Elimination Of Duplicate In RFID Data Streams:

Chun-Hee Lee and Chin-Wan Chung proposed three algorithms for duplicate elimination in RFID data [13] in 2011. RFID causes a problem when multiple RFID readers find a single RFID tag at same time. Hence, it results in duplicate data. The time field present in a RFID tag comes into play during detection of tags. The other fields of RFID include location and EPC. These fields are used in identification and position of RFID readers. It is hard to detect maximum duplicate data streams in a tiny amount of space. To overcome this problem, three algorithms were used to remove duplicate data by one pass. The effective elimination algorithms are Bloom filter, Time Bloom filter and Time Interval Bloom filter which were used in fault detection and elimination. Time Interval Bloom Filter needs much more space than the Time Bloom Filter. Time Bloom Filter relies on time information to detect RFID duplicates. When RFID data arrives at the server, data passes through time bloom filter and checks the condition whether the data is duplicate or not. Duplicate data streams are removed. Time Bloom Filter and Time Interval Bloom Filter do not create false negative errors.

CONCLUSION

This paper presents a detailed analysis of various applications of RFID. RFID enhances the overall performance and reduces the memory size. Accurate identification of objects is used in all applications such as

department store and healthcare application. This paper highlights the advantages of automatic tracking over manual tracking. This technology finds its complete potency in embedded systems.

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