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Unknown Tag Identification in Large RFID Systems: An Efficient And Complete Solution

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Abstract: Radio-Frequency Identification(RFID) technology brings revolutionary changes to many fields like retail industry. One important research issue in large RFID systems is the identification of unknown tags, i.e., tags that just entered the system but have not been interrogated by reader(s) covering them yet. Unknown tag identification plays a critical role in automatic inventory management and misplaced tag discovery, but it is far from thoroughly investigated. Existing solutions either trivially interrogate all the tags in the system or thus are highly time inefficient due to re-identification of already identified tags, or use probabilistic approaches that cannot guarantee complete identification of all the unknown tags. In this paper, we propose a series of protocols that can identify all of the unknown tags with high time efficiency. We develop several novel techniques to quickly deactivate already identified tags and prevent them from replying during the interrogation of unknown tags, which avoids re-identification of these tags and consequently improves time efficiency. To our knowledge, our protocols are the first non-trivial solutions that guarantee complete identification of all the unknown tags. We illustrate the effectiveness of our protocols through both rigorous theoretical analysis and extensive simulations. Simulation results show that our protocols can save up to 70 percent time when compared with the best existing solutions.

Keywords: RFID System, Unknown Tag Identification, Time Efficiency, Slot Pairing, Multiple Reselections.

I. INTRODUCTION

Protection of privacy is often demanded, but rarely implemented. Each time a new consumer technology is introduced, the protection of private data is seen as a burden to quick deployment. Later on, adding protection becomes even more prohibitive due to the high cost of upgrading legacy installations. For many of today's applications in which privacy is desired, it is no longer possible to add protection to the already deployed infrastructure. This includes e-mail and credit cards—two applications that disclose much more information than necessary to potentially un trusted transport networks and intermediate parties. Radio-readable credit cards provide a recent example of a large scale system whose current lack of privacy protection has raised some alarm [29]. Radio Frequency Identification (RFID) tags are the next example of an emerging and increasingly widespread technology for which the lack of adequate protection poses a privacy hazard. RFID tags on consumer items enable tracking of the items through the logistics chain. The tags will, among other uses, replace barcodes on retail products and be integrated in clothing—all in an attempt to help computers learn about physical objects in their vicinity. Often cited examples of why computers should gain this ability include washing machines that could prevent clothes from being washed at the wrong temperature, cars that automatically detect their owner approaching, and automated grocery stores where computers track each item to optimally stock, order, and recall products.

Available privacy protection measures are seen as prohibitively expensive, and implementers of RFID systems are concerned that making protection mandatory will further delay the wide-scale rollout of RFIDs, which has already been postponed several times due to issues with reading range and manufacturing cost. Radio Frequency identification, or RFID, is a generic term for technologies that are used for auto–identification of people or object using radio waves. In this technology a unique serial number is stored to identify a person or an object and other related information, on a microchip of silicon that is attached to an antenna which is in turn attached to a RFID reader also called as interrogator. The antenna enables the chip to transmit the identification information to e reader then the reader converts the radio waves reflected back from the RFID tag into digital information. We focus on an important but not thoroughly investigated problem, unknown tag identification inlarge RFID systems. Unknown tags are those tags that just entered the system but have not been interrogated by the reader(s) covering them yet. For instance, in a large warehouse, the frequent loading of new products introduces unknown tags into the system, which should be interrogated in time in order to support automatic and efficient product management. Misplaced tags due to disoperation of stevedores could also be treated as unknown tags by reader(s) currently covering them. Timely interrogation of these unknown tags should be carried out to avoid considerable economic profit loss caused by misplace men terrors.

II. MAIN OBJECTIVE

The main objective of this system is to reducing the purchasing time in retail shops. This system uses automated technology by using RFID. The most related work on unknown tag identification is the continuous scanning (CU) scheme [19], which is a probabilistic scheme that cannot guarantee complete identification of all the unknown tags. In safety-critical applications like medicine management in hospitals, it is strictly required that all the unknown tags must be identified. The CU scheme cannot meet this requirement. The execution time of CU increases along with the increase of the probability required to interrogate each unknown tag.

III. EXISTING SYSTEM

In existing system there should be the need of manual power for billing of the every product bought by the user. So the manual power and the time are wasted. So we go for the proposed system to overcome the disadvantage of the existing system. Early works on RFID tag identification focus on collision arbitration for a single reader. They can be classified into two categories: ALOHA-based protocols and tree-based protocols. The authors investigated optimization of time efficiency and energy efficiency, respectively, by adjusting frame size in ALOHA-based tag identification protocols. The authors proposed adaptive tree traversal methods to improve time efficiency of treebased protocols. Kang et al. and Xie et al. reported that tag identification throughput degrades in real deployment. These works all target at identifying all the tags in the system, and thus are not efficient to solve the unknown tag identification problem considered in this paper. Mobile readers can provide flexible tag identification in infrastructure-less (i.e., with no preinstalled readers) RFID systems. Xie et al. reported observations on the relationship between identification throughput and the transmitting power of the readers. Based on the observations, they designed algorithms to optimize energy and time efficiency of the reader in large RFID systems containing more than one hundred tags.

The most related work is the CU scheme proposed in. It uses a probabilistic method to identify unknown tags, and thus cannot guarantee complete identification of all the unknown tags. CU first predicts which slot should be empty according to the IDs of known tags, assuming noun known tags exist. In the predicted non-empty slots, the reader sends ACK to temporarily prohibit replies from known tags. In the predicted empty slots, the reader sends NAK to keep unknown tags active for following identification. It then collects IDs of active unknown tags. Unavoidably, some unknown tags may be prohibited in the predicted non-empty slots and thus cannot be identified. The protocol runs multiple rounds to guarantee that the probability that a required fraction of unknown tags are identified is higher than a threshold. However, CU cannot ensure that all the unknown tags are identified. In contrast, the protocols proposed in this paper adopt deterministic approaches to identifying all the unknown tags in the system. Furthermore, two novel techniques, namely slot paring and multiple reselections, are developed to reduce the time needed to identify unknown tags.

Disadvantages of Existing System:

- This system simplifies lifestyle.
- Reliability is low; it does not suitable for longer time applications.
- Monitoring is too tough some time monitoring requires high manual power.

IV. PROPOSED SYSTEM

In proposed system RFID tag should be read only once, with this customer can pay bill without any delay Consider a large RFID system consisting of a reader R. All the known tag IDs are recorded in a back-end server as shown in Fig.1. The objective is to collect all the unknown tag IDs as quickly as possible. Note that in the current RFID tag identification protocols, the reader has no simple way to differentiate unknown tags from known tags, and thus has to endure the interference from known tags when identifying unknown tags. This work aims to design novel techniques to quickly recognize known tags and prohibit their replying during the identification of unknown tags. The protocols proposed in this paper can also be applied to RFID systems containing multiple readers. In such cases, we resort to existing reader scheduling algorithms, to obtain a conflict-free schedule of readers and run our protocols on every reader. Our protocols could also be tailored for mobile reader scenario(s) by treating tags identified at the previous site as known tags at the current site. The reader(s) can access the back-end server via wiredor wireless link(s) to retrieve the known tag list before running the protocols and update the list afterwards. It is possible that known tags might leave the system, and there are some researches on detecting such missing tags. In this work, we mainly focus on the unknown tag identification problem and assume that no known tags leave the system during the identification of unknown tags, which is usually very short, e.g., several minutes.

This assumption has been taken in many excellent previous works. To do this, the reader needs to trace which known tags have left the system before executing our protocols, and update the known tag list in the back-end server accordingly. In case that the reader cannot trace which known tags have left, we resort to missing tag detection protocols to find which known tag shave left and update the known tag list accordingly. After unknown tags have been identified, we insert their IDs into the database to keep the known tag list updated. The reader uses indicator vectors to send some frame arranging information to tags. An indicator vector is a vector of bits that can be received and interpreted by tags. For example, we can set the bit associated with a slot to “1” to prevent tags selecting this slot from transmitting. This technique has been used in many existing researches to improve protocol efficiency. Here we adopt the method given in to implement indicator vector on top of EPCG1G2 compliant tags. The indicator vector is divided into segments of 96 bits long and each segment is encapsulated into a tag ID. The reader broadcasts segments one after other. Tags need to buffer only one segment in which their corresponding bit resides in. We can also add cyclic-redundancy check (CRC) code to each segment to ensure that the segment could be correctly received. In this section we develop a technique to recognize known tags and unknown tags by comparing the actually received replies in a slot with the expected relies. Being aware of known tags' ID, the reader knows what tags will transmit in which slot. Consequently, the reader knows the expected reply number in each slot (i.e., the number of known tags transmitting in this slot) if there are noun known tags. However, replies from unknown tags might make the actual reply number in a slot different from the expected value.

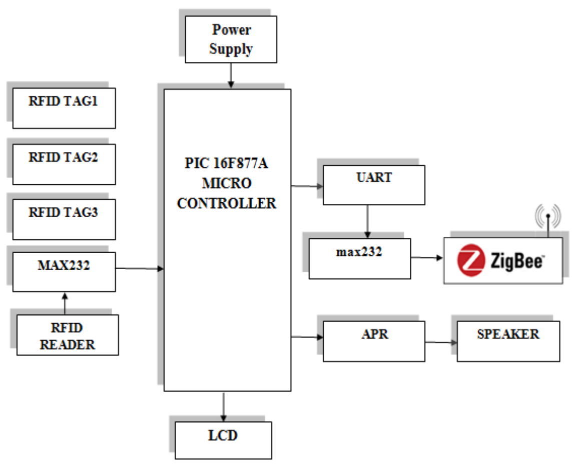

Fig.1. Block diagram.

The matching/mismatching between the two numbers provides us opportunities to recognize known tags and unknown tags: If the actual reply number equals he expected reply number, then all the replying tags must be known tags; on the other hand, if the actual reply number is larger than the expected value, there must be some unknown tags replying. After recognizing known tags and unknown tags, the reader deactivates or labels them accordingly. For recognized known tags, the reader deactivates them in both of the two phases in our protocol. In contrast, for recognized unknown tags, the readers make them temporally inactive only in the first phase, which we call unknown tag labeling. The purpose of labeling is to prevent unknown tags from interfering the recognition of known tags. All the labeled unknown tags will become active again in the second phase to perform identification as shown in Fig.2. We implement the known/unknown tag recognition method as follows. In the ALOHA protocol the reader can obtain only coarse-grained status of a slot: empty (the reply number is 0), singleton (the reply number is 1), and collision (the reply number is larger than 1). Because the reader cannot know the exact reply number in a collision slot, it cannot determine whether the actual reply number in a collision slot matches its expected value or not.

Advantages of Proposed System:

- The proposed system is highly reliable and fast in response.
- It is easy to monitor and easy to develop.
- With the implementation of cost efficient & flexible design we can save the power.

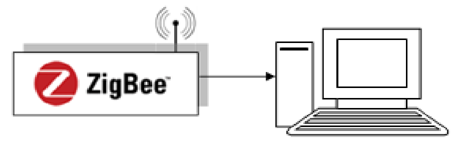

Fig.2. Control section.

V. HARDWARE COMPONENTS

ARM7: The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers. This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core. Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as Thumb, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind Thumb is that of a super-reduced instruction set. Essentially, the ARM7TDMI-S processor has two instruction sets:

- The standard 32-bit ARM set.
- A 16-bit Thumb set.

MAX232 IC: The MAX232 is an IC, first created by Maxim Integrated Products, that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single + 5 V supply via on-chip charge pumps and external capacitors. This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to + 5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 VTTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V.

Liquid Crystal Display (LCD): LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

ZIGBEE: ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks as shown in Fig.3. The standard takes full advantage of the IEEE 802.15.4 physical radio specification and operates in unlicensed bands worldwide at the following frequencies: 2.400–2.484 GHz, 902-928 MHz and 868.0–868.6 MHz

- The power levels (down from 5v to 3.3v) to power the zigbee module.
- The communication lines (TX, RX, DIN and DOUT) to the appropriate voltages.

Fig.3. ZIGBEE.

RFID Reader: The reader, or scanner, functions similarly to a barcode scanner; however, while a barcode scanner uses a laser beam to scan the barcode, an RFID scanner uses electromagnetic waves. To transmit these waves, the scanner uses an antenna that transmits a signal, communicating with the tags antenna as shown in Fig.4. The tags antenna receives data from the scanner and transmits its particular chip information to the scanner.

Fig.4 RFID Reader.

RFID Tag: RFID tag is a small device which stores and sends data to RFID reader. They are categorized in two types – active tag and passive tag as shown in Fig.5. Active tags are those which contain an internal battery and do not require power from the reader. Typically active tags have a longer distance range than passive tags. Passive tags are smaller and lighter in size than the active tags. They do not contain an internal battery and thus depend on RFID reader for operating power and certainly have a low range limited up to few meters.

Fig.5. RFID TAG.

APR 9600 VOICE IC: The APR9600 device offers true single-chip voice recording, non-volatile storage, and playback capability for 40 to 60 seconds. This IC can be used to record and playback of maximum no. of 8 messages. The replayed sound exhibits high quality with a low noise level. Sampling rate for a 60 second recording period is 4.2 kHz as shown in Figs.6 and 7.

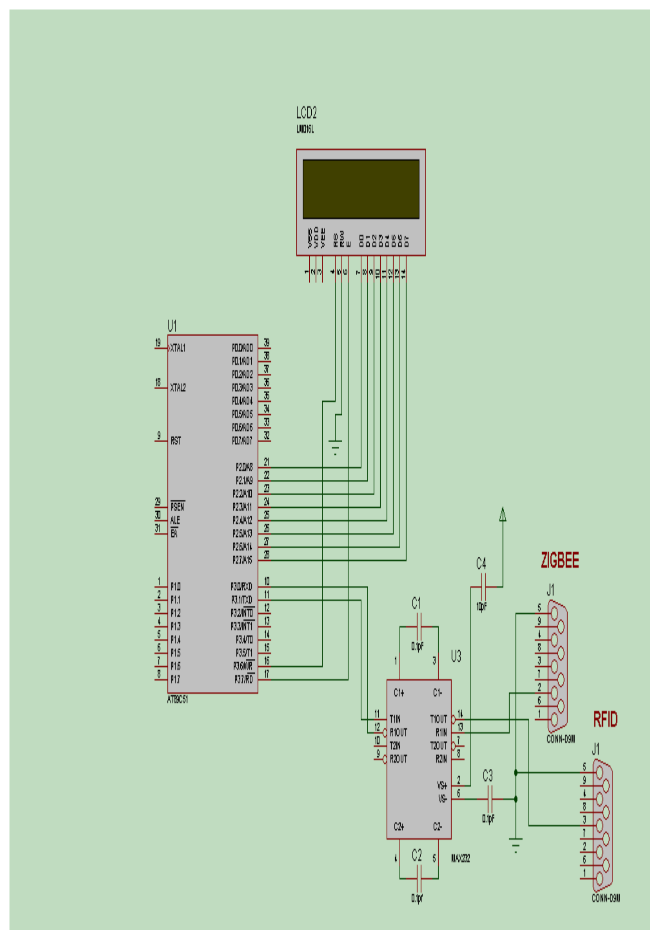

Fig.6. Schematic Diagram of Trolley Section.

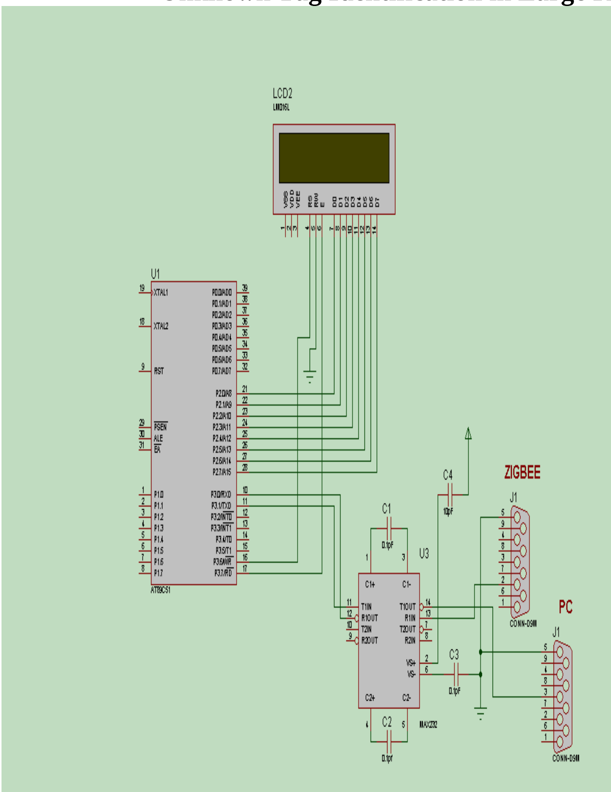

Fig 7. Schematic Diagram of Cash collection Section.

VI. SIMULATION AND DESIGN

Simulation results of this paper is as shown in bellow Figs.8 to 11.

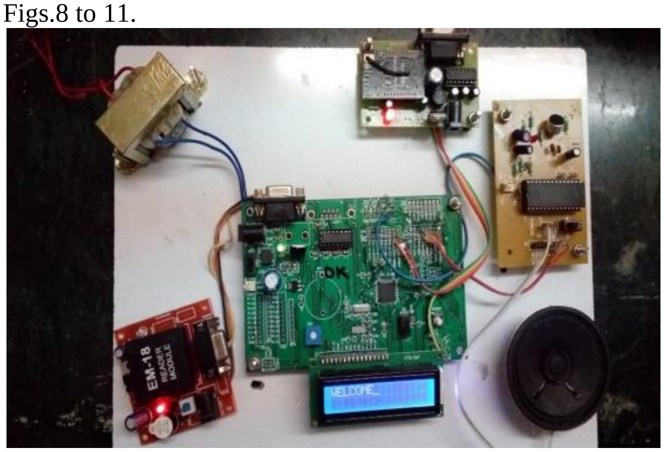

Fig.8. Setup of Project kit displaying Welcome.

Fig.9. Monitor section showing Welcome.

Fig.10. Setup of Project kit displaying Item 1 & Its price.

Fig.11. Setup of Project kit displaying Item 2 & Its price.

Working Principle: In the proposed system it is mainly used in the shopping malls. In shopping malls every product consists of RFID tag. RFID reader is placed in the trolley section. Whenever the consumer places any object in his trolley immediately RFID TAG connected to that particular object is read by the RFID READER & sends that information through zigbee and stores in the PC. Along with this when RFID READER reads the information it will intimate the consumer about the cost with APR VOICE. The control section is controlled by the owner. The information received from the zigbee is stored in the PC. It indicates about the products in particular trolley section and billing information. With this the customer can easily pay bill without any delay.

Applications:

- Warehouse management
- Object tracking,
- Inventory control.
- Shopping malls
- Parking Arena's
- Toll collection's

Advantages:

- Easy to use because only once RFID tag will be read

- Easy to operate in shopping malls
- It is flexible to use and portable
- High efficiency

Future Scope: In the future, we will investigate how to further reduce the impact of known tags on collecting unknown tags. Hence we can coordinate with the high processors or controllers for fast processing and easy to control the huge tags.

VII. CONCLUSION

Equally important as the missing tag identification, unknown tag identification deserves more investigation in RFID systems. It is not the reverse way of missing tag identification to completely identify unknown tags. In this paper, we propose a series of protocols to perform fast and complete unknown tag identification in a large RFID system. Simulation results show the superior performance of the proposed protocols. While in an ideal unknown identification protocol the execution time should depend on only the number of unknown tags, in the proposed protocols the execution time is still slightly impacted by known tags to some extent.

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