Applying RFID Technology to construct an Elegant Hospital Environment

A.Anny Leema[1], Dr.Hemalatha.M[2]

[1] Assistant Professor, Computer Applications Department, B.S.Abdur Rahman University
PhD Scholar, Karpagam University, Coimbatore, India

[2] Head of MSc. Software Systems,
Karpagam University, Coimbatore, India

Abstract

Radio frequency identification (RFID) technology has seen increasing adoption rates in applications that range from supply chain management, asset tracking, Medical/Health Care applications, People tracking, Manufacturing, Retail, Warehouses, and Livestock Timing. Of these, Medical/Health care applications are of more importance because minute errors in it can cost heavy financial and personal losses. The success of these applications depends heavily on the quality of the data stream generated by the RFID readers. Efficient and accurate data cleaning is an essential task for the successful deployment of RFID systems. Hence this paper gives the brief introduction of RFID terminologies and cleaning methods to provide accurate RFID data to applications. It also outlines a patient management system which helps hospitals to build a better, more collaborative environment between different departments, such as the wards, medication, examination, and payment. Indeed used in hospital to bring down the health care costs, optimizing business processes, streamline patient identification processes and improve patient safety.

Keywords: RFID technology, cleaning methods, smart hospital, health care systems

1. Introduction

RFID technology uses radio-frequency waves to automatically identify people or objects. There are several methods of identification, but the most common is to store a serial number that identifies a person or object, and perhaps other information, on a microchip that is attached to an antenna (the chip and the antenna together are called an RFID transponder or an RFID tag). The antenna enables the chip to transmit the identification information to a reader [2]. The reader converts the radio waves reflected back from the RFID tag into digital information that can then be passed on to computers that can make use of it. RFID is automatic and fast and will replace the barcode system in the near future. The big difference between RFID and barcodes is line-of-sight technology. That is, a scanner has to see the barcode to read it, which means people usually have to orient the barcode toward a scanner for it to be read, RFID by contrast, doesn't require line of sight. RFID tags can be read as long as they are within range of a reader[5].

RFID technology is widely used in diverse application such as supply chain automation, Asset tracking, Medical/Health Care applications, People tracking, Manufacturing, Retail, Warehouses, and Livestock Timing. Of these, Medical/Health care applications are of more importance because minute errors in it can cost heavy financial and personal losses. For hospitals and healthcare systems, increasing the operational efficiency is the primary target. It is a tough task to keep up the effectiveness and monitor each and every patient [7]. However, utilization of RFID (Radio Frequency Identification) technology in addition to reducing the health care costs facilitates automating and streamlining patient identification processes in

hospitals and use of mobile devices like PDA, smart phones, design of health care management systems etc., [4]. The emerging RFID technology is rapidly becoming the standard for tracking inventory, identifying patients, and managing personnel in hospitals [7]. In hospitals patient safety is critically important; lives are at stake, and zero defects should be the established standard. At the same time, hospitals are pressured to reduce costs. Therefore, when developing strategic objectives, technologies that reduce operating expenses while providing increased patient safety must be thoroughly tested and evaluated. Radio frequency identification (RFID) is one technology that holds great promise.

Recent years, in almost every country in the world, substantial financial resources have been allocated to the health care sector. Technological development and modern medicine practices are amongst the outstanding factors triggering this shift. Achieving a high operational efficiency in the health care sector is an essential goal for organizational performance evaluation. Efficiency uses to be considered as the primary indicator of hospital performance [1].

The goal of this paper is to show how RFID contributes to build an elegant hospital by optimizing business processes, reducing errors and improving patient safety. This section starts by a short introduction to the RFID technology and define some of its main concepts and standards. The second section describes some interesting hospital use cases that could benefit from RFID and the third section outlines the cleaning methods and finally developed a health care system. We also summarized the open problems that still have to be solved before RFID is fully adopted by the healthcare community.

2. Building an elegant Hospital

2.1Existing Problems in Hospital

Healthcare providers (i.e., hospitals) traditionally use a paper-based ‘flow chart’ to capture patient information during registration time, which is updated by the on duty nurse and handed over to the incoming staff at the end of each shift. Although, the nurses spent large amount of time on updating the paperwork at the bedside of the patient, it is not always accurate, because this is handwritten.

In thousands of hospitals across the world, blood transfusion is an everyday business, but fraught with risks. This is because contaminated blood may be transfused to a healthy patient or receiving wrong type of blood. Data from US hospitals shows an alarming number of cases of medical negligence or mistakes, many of which are related to blood transfusion.

Many health professionals are concerned about the growing number of patients who are misidentified before, during or after medical treatment. Indeed, patient identification error may lead to improper dosage of medication to patient, as well as having invasive procedure done. Other related patient identification errors could lead to inaccurate lab work and results reported for the wrong person, having effects such as misdiagnoses and serious medication errors [4].

2.2 Potential Benefits of RFID technology

The RFID solution to the above said problem is to embed a tag into the blood bag label itself. The parametric who transfuses the blood can scan the bag before transferring. He typically enters the patient ID number and the patient also has a wrist band RFID tag which identifies him uniquely. In case the wrong blood bag is scanned, the reader can throw up a warning given below and the patient is saved from wrong treatment.[3]

WARNING BLOOD MISMATCH!!!	
The Blood bag is for patient ANNY Patient ID A1000	The patient on the bed is ANNIE Patient ID is A0100

The RFID patient tracking kit consists of RFID wristbands, a PDA handheld reader, a desktop HF reader and necessary software. Because of automated data capture, the RFID patient tracking kit brings improved

efficiency. The waterproof, non-allergic wristband can be reprogrammed to enable patient information to be stored and transferred to and from RFID readers, information systems, and medical devices in hospital. The Handheld RFID reader is used to receive the patient's real-time information just beside the beds, whereas desktop reader is used to read/write wristband's information beside computer to save time. Hospitals can use this RFID patient tracking kit to boost efficiency and accuracy while reducing costly and dangerous errors, and giving patient more privacy. [6]

Patients are monitored in many hospitals whether proper care is given or not. These systems tend to reduce the data-entry workload of nurses, and also let them spend more time caring for patients and automate the process of billing. Additionally, hospitals are tracking high-value assets, including gurneys, wheel chairs, oxygen pumps and defibrillators. These systems reduce the time employees spend looking for assets, improve asset utilization and enhance the hospitals' ability to performed scheduled maintenance.

Patient bracelets embedded with RFID technology securely tracks patient movement from admission to discharge. The Orthopedic Hospital of Oklahoma (OHO) uses RFID technology and thin client computing solution from Sun Microsystems Inc. to significantly enhance the overall hospital experience for its patients.

An Active Wave RFID system can be used to track patients, doctors and expensive equipment in hospitals in real time. RFID tags can be attached to the ID bracelets of all patients, or just patients requiring special attention, so their location can be tracked continuously. It also Restrict access to drugs, pediatrics, and other high-threat areas to authorized staff.

Moreover, RFID readers are placed at strategic places within the hospital:

• RFID gates are inclined at entrances and exits of the hospital.

• At least one RFID reader can be placed for each operating theatre.

• RFID sensors are placed in strategic galleries and important offices. In the best case, every office should contain an RFID reader: either placed next to the door or under the desks.

• The staff members (doctors, nurses, caregivers and other employees) each have a handheld (PDA, mobile phone, etc.) equipped with an RFID reader and possibly with a wireless (e.g. WiFi) connection to the web.

3 Cleaning Methods

Data cleaning is essential for the correct interpretation and analysis of RFID data. To increase patients' safety the major challenge is to clean the data so that it is "fit for use". Efficient and accurate data cleaning is an essential task for the successful deployment of RFID systems. The standard data-cleaning mechanism in most systems is a *temporal "smoothing filter"*. The goal is to reduce or eliminate dropped readings by giving each tag more opportunities to be read within the smoothing window. SMURF which was proposed by UC Berkeley dynamically adjusts the size of a window to pre-treat RFID data. However, SMURF does not work well in determining the size of slide window for frequently moving tags.

In EPS (Extensible Sensor Stream Processing) the static size of the window is the limitation of the approach because large window induces false positives and small window cannot fill false negatives. A new cleaning approach based on the virtual spatial granularity, named bSpace overcome the weakness of the existing techniques. It uses a Bayesian estimation strategy to compute the times that the tag has been detected, in order to fill up false negatives for dynamic tags; and it uses the rules to solve false positives.

In order for RFID technology to become feasible, RFID middleware must be able to produce reliable streams describing the physical world. Cleaning of RFID data sets can be an expensive problem. Existing work on RFID cleaning mainly focused on improving the accuracy of a stand-alone technique and largely ignored costs. Cost conscious cleaning method is based on Dynamic Bayesian networks. The above said cleaning algorithms have its own benefits and drawbacks. SMURF is one of the

recognized data cleaning approaches. [8] However it does not have good performance when tag moves rapidly in and out of reader's communication range, reading frequency and velocity of tag movement. SMURF gives only the empirical value of δ and does not tell how to calculate it [9]. To improve the algorithm performance the size of the sliding window is computed by adjusting the parameter δ. The simulation shows the error rate is lower and not completely removed.

4 Patient Management System

The important data (e.g., patient ID, name, age, location, drug allergies, blood group, drugs that the patient is on today) can be stored in the patient's back-end databases for processing. The databases containing patient data can also be linked through Internet into other hospitals databases [5]. The Patient Management System's administrator can issue unused tag (wristband) to every patient at registration time. Healthcare professionals (e.g., doctors, consultants) can edit/update password protected patient's medical record for increased patient and data security by clicking the Update Patient Button. This PMS can be implemented in departments (e.g., medicine, surgery, obstetrics and gynecology, pediatrics) in both public and private hospitals for fast and accurate patient identification without human intervention. Using HPMS, health care providers (e.g., hospitals) have a chance to track fast and accurate patient identification, improve patient's safety by capturing basic data (such as patient unique ID, name, blood group, drug allergies, drugs that the patient is on today), prevent/reduce medical errors, increases efficiency and productivity, and cost savings through wireless communication. The PMS also helps hospitals to build a better, more collaborative environment between different departments, such as the wards, medication, examination, and payment.

5 Conclusions and Future Work

Health care is an important sector that can obtain great benefits from the use of the RFID technology. In this paper, we have analyzed the use of RFID in the health care sector and also described some interesting applications with promising perspectives. Although a number of great ideas and systems can be found in the literature, there is a number of issues that have not been analyzed yet. [7] We summarize some points that should be addressed in the near future:

1. When talking about pasting radio frequency tags on drug packages, there are concerns that exposure to electromagnetic energy could affect product quality.
2. RFID-based systems can fail due to several reasons (e.g. RFID tags can be destroyed accidentally or, communications can be broken due to interferences).There is a need for real-time fault tolerant RFID systems able to deal with situations in which patients lives could be in danger.
3. RFID components interact wirelessly, thus, attackers have plenty of opportunities to eavesdrop communications and obtain private data of the patients. [6]These data can be used by the eavesdropper to blackmail patients, or by an insuring company to raise prices to their clients. Security and privacy in RFID technology is a very active research field that has the challenge to design scalable and cheap protocols to guarantee the privacy and security of RFID users.

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First Author A.Anny Leema completed MCA., MPhil., in Computer Science and working as an Assistant Professor in the dept of Computer Applications, B.S.Abdur Rahman University. She has ten years of experience in teaching. She has presented several papers in National conferences and two in International Conference. Her area of interest is Data Mining, Cybercrime and E-learning. She is currently doing her research in the area Data Warehousing under the guidance of Dr. Hemalatha., Assistant Professor and Head, dept of software systems in Karpagam University

Second Author Dr. Hemaltha completed MCA, MPhil., PhD in Computer Science and currently working as a Asst Professor and Head, dept of software systems in Karpagam University. She has ten years of experience in teaching. Published twenty seven papers in International journals and presented several papers in National and international conference. .Area of research is Data mining, Software Engineering, bioinformatics and Neural Network.