

RFID Based Smart Hospital Management System: A Conceptual Framework

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Abstract— The integration of information and communication technology (ICT) in the healthcare sector has been one of the important areas of research since last two decades. The application of RFID (Radio Frequency Identification) technology is widely used in healthcare sector to provide better, reliable and secure services. RFID systems are integrated into hospital information systems and provide full automation and streamline the important modules of patient identification, staff allocation, doctors, medicines and treatments. In this paper, we propose RFID based conceptual framework for smart hospital management system which provides a safe and secure patient data management system. We also highlight the importance of RFID in healthcare domain with the help of an example case study with a working prototype application.

Keywords- Information and communication technology; radio frequency identification (RFID); hospital information systems; patient data management

I. INTRODUCTION

The rapid growth in ICT has a profound impact on our lives and application of ICT is almost in every domain including education, engineering, business, management, sports, social sciences, finance, banking, and in medical and health sciences. There is tremendous growth and potential in the application of ICT in medical and health domain [1]. Healthcare organizations in general are very much aware of the benefits of using ICT in their day-to-day management to overcome different challenges, including increasing financial pressure, technical human resource, reduce medical errors, improve the quality of care, to introduce patient safety and security measures. RFID technology provides cost effective and reliable solutions to the above mentioned problems [1,2]. RFID technology helps us to see and monitor the status of the patient by tracking all the health services given to patients. RFID technology can be integrated with the hospital information system and patient databases to record instant data, which can be accessed in real time.

There are number of proposed models for RFID based implementations in healthcare domain in the literature [1,3, 4]. Yao [1] and Wamba [4] presented the detailed survey of RFID based applications in healthcare sector along with the benefits and barriers in implementation. Some of the important implementations of RFID application in health domain includes ultra-wideband RFID system [3] for Washington Medical Center, USA used to track items for moving patients and is based on active RFID tags, Positive

patient identification system [5] used in university college hospital Galway for patient identification using hand held devices, context-aware system [6] in university of Aarhus, Denmark for finger print indemnification and for drug administration. Other significant contributions in this domain include [7 - 10].

Patient database is one of the components of hospital information system (HIS) [11, 12]. HIS contains data for different modules ranging from hospital supply chain management, billing data, staff management, pharmacy, drug management, medical equipment, laboratory management and patient management. Patient is one of the most important entities in a hospital environment because most of the data revolves around the patient such as admission, status, treatment, follow-up, medication and testing.

The integration of RFID technology with the hospital information system will improve the quality of patient care and safety by tracking the real time status of patient treatment, clinical staff, doctors, ward allocation and critical clinical equipment availability for patients. We have identified the key entities in smart hospital system and developed the database model (ERM) by integrating RFID technology. We also proposed the architecture for RFID based smart hospital systems. On the basis of the proposed architecture We have developed a working prototype application.

The paper is composed of five sections; section two followed by introduction describes RFID technology. Section three discusses the use of RFID in healthcare sector followed by section four i.e. proposed RFID based Smart hospital model and architecture followed by conclusion.

II. RFID TECHNOLOGY

Radio-frequency identification (RFID) is a wireless sensor based technology [13] which uses radio frequency in the form of electromagnetic fields to transfer data among objects. RFID has the capability to automatically identify and track objects with the help of tags attached to those objects. The RFID tags contain electronically stored information which is designed for short and long ranges as per the application requirement. Figure 1, illustrates this RFID based system components. Short range tags are read by magnetic fields and they act as transponder to emit microwaves. Long range tags usually worked with a power source (battery) and the range of these tags are in hundreds of meters. RFID technology has many advantages over

traditional Bar code technology and it doesn't require the tag to be in line of sight of RFID reader (scanner). Secondly active tags can provide instant information on real time basis.

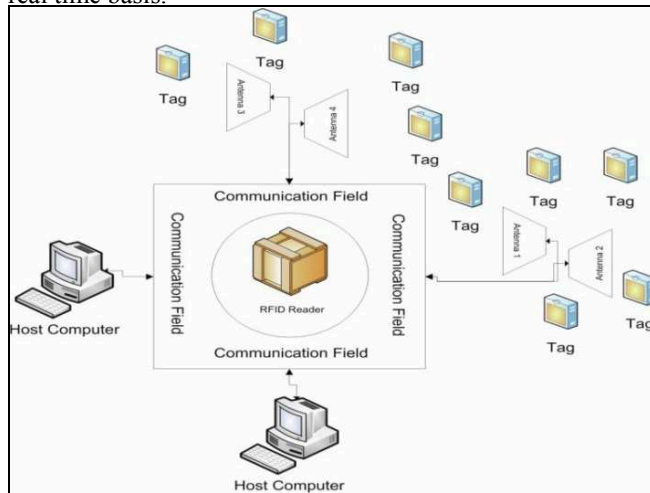


Figure 1. Components of RFID systems

RFID tags can be classified as active and passive tags. An active tag has an in built local power in terms of battery which communicates and sporadically transmits identification signal. In comparison a passive tag does not require battery and it is comparatively small and less costly than active tags. The choice of tags and its structural properties varies a lot and it is up to the implementation and user requirement. Tags are further classified as read only as in case of superstore or general store, where a serial number is assigned to a product and is used as key for the database and writable (programmable) tags are written according to the product information and used for data manipulation.

RFID tags has two important components, first an integrated circuit which is responsible for information storage, processing, modulating and demodulating of RF signal and collects signals from reader. The other component is an antenna for receiving and transmitting the signal. The RFID tags are either based on chip-wired logic or a data processor (programmable) for processing the sensor data.

The cost of active and passive tags have decreased dramatically in the last five years which increases the demand of RFID technology in the organizations replacing old systems of card readers and Bar code technology. RFID technology is widely used in asset management, super markets, animals or people tracking, toll collection and payments, machine readable documents scanning, transportation, vehicle tracking and in medical and health sector.

III. RFID IN HEALTHCARE

The use of RFID technology in healthcare sector is ranging from hospital supply chain management, asset tracking, tracking of movable devices, medication, staff duties and attendance, patient monitoring and tracking, treatments and in other operational works. One of the most important objectives of using RFID technology in healthcare is to improve the quality of care by minimizing the medical and clinical errors. Healthcare industry has

many challenges [1] (figure 2) and RFID technology provide better solutions to these problems. RFID technology provides more efficient, reliable way to track information in real time [11, 14].

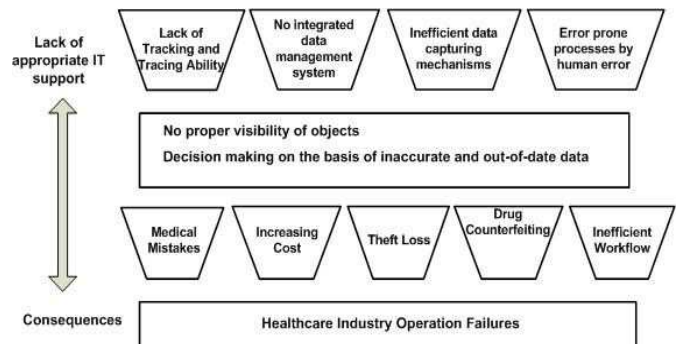


Figure 2. Challenges in healthcare [1]

Integration of RFID tagged data with business processes and applications can help to characterize and optimize the process used to deliver better healthcare services. RFID based applications in health domain may be divided into two broad categories; 1) inventory management and control, 2) workflow and process optimization. RFID has made its way into almost all the day to day operations of a Healthcare facility. Figure 3 illustrates the interaction between different components of an RFID system. It is tailored to a health care setting.



Figure 3. RFID System Diagram

There are many examples of successful implementations of RFID technology in healthcare domain, which includes in USA the company CenTrak deployed infrared monitors in medical facility rooms to collect data from patients, staff and mobile medical assets who have assigned RFID badges. In Singapore, Tan Tock Seng Hospital uses RFID technology to tag all patients with the help of Thermo Sensors to track and monitor patients. In USA in the year 2004, the Federal Development Authority approved a project for developing RFID chips that can be implanted in humans. This chip was designed by VeriChip Corporation and it contains complete personal medical information (health record) of an individual.

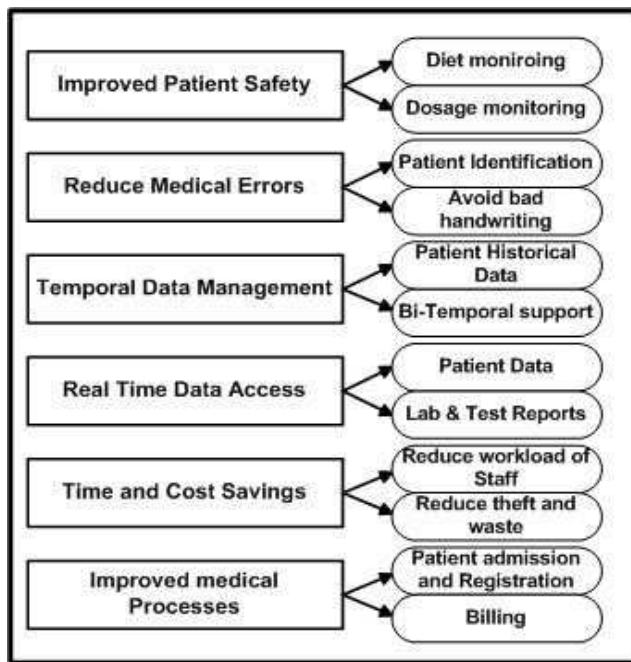


Figure 4. RFID Benefits

Benefits of RFID technology in healthcare sector [2] is far reaching and improves the quality of care with reliable, accurate and timely information (figure 4). RFID

technology is now integrated with the hospital information systems with the help of software (application layer) to increase its efficiency. The data is stored in the database server on real time and information regarding patients, staff and equipment can be tracked in real time. Real-time data or temporal (time-stamped) [15] data is recorded and this data can be used with decision support systems to improve the decision making capability and to prove compliance with various industry regulations. This real time data is collected 24/7 which can be further explored and helpful to determine trends and use for future planning.

IV. HOSPITAL DATA MANAGEMENT USING RFID: CASE STUDY

The hospital case study conducted by this research shows that there are objects which need to be considered when developing a data model to represent information flow in a hospital environment. These objects (entities) include patient, staff, doctors, medications, equipment, controls, assets, finance which are associated with other entities and locations. The finite set of events within the hospital will be captured through observation, forms, reports and interviews

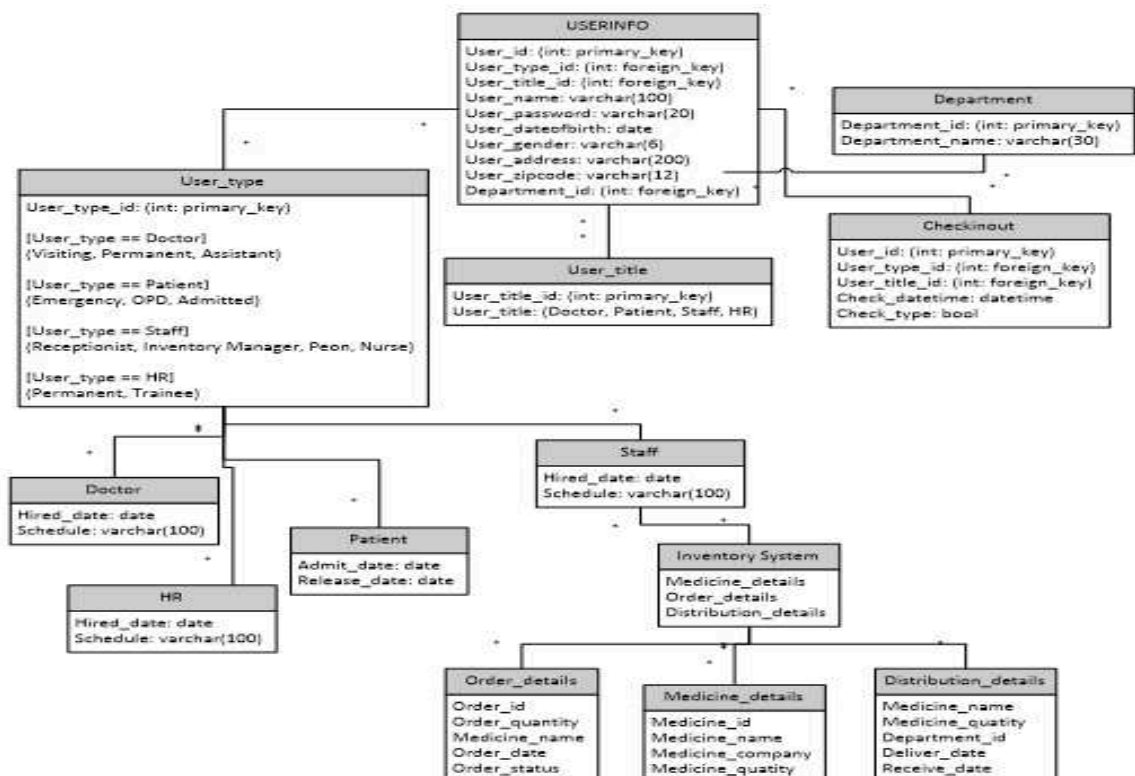


Figure 5. ER Model

in a real environment and considering the given health policy [16]. Patient is the key entity in health information system and most of the information flows around patient.

The following important components have been observed in the case of patient admitting in a hospital for treatment. However, the in depth investigation of each component is yet to be explored. The ER model is represented in the figure 5.

- The number of healthcare professionals dealing with patients.
- The possible number of actions/services to patients' movement processes.
- The number of resources involved in managing patient in a hospital.
- Role of pharmacy in providing medicine as per subscription to patient in the hospital
- Patient treatment plan
- Patient's response on certain clinical activities
- The movement of patients in a hospital(emergency, OT, ICU, Ward)

Our objective is to highlight how the RFID technology can help in medical facilities and hospitals. Therefore, we used an example case study of RFID based smart hospital system. We have identified the important objects and actors to be tagged.

- Permanent Staff (the doctors, nurses, caregivers and other staff members) and persistent patients will be allotted a "Smart badge/card", storing their employee/patient unique identifier (ID), and some information about him/her (e.g. a digital picture, a unique patient code, doctor's specialty etc.)
- Historical data of all the patients, doctors and staff members which is in the form of paper files are tagged with self-adhesive RFID labels having a unique ID.
- Via this Smart badge/card, check-in check-out of staff members can be recorded easily and automatically.
- Warehouse of blister packs and other drugs will be managed via Electronic Product Code (EPC) system.

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

- RFID scanners are installed at the main entrances and exits of the hospital.
- OT (operating theater) and special wards also have RFID scanner.
- RFID sensors are carefully placed in wards, beds, labs, warehouse and other important vicinities to ensure secure access to authorize persons.

And an Online Web-based Patient Report Management system is maintained, so that patient as well as the patient's doctor can easily access the lab reports and results online.

A. RFID Device (SC403)

It is an access control device which worked as master-slave system that is based on wiegand-in interface for external reader connection. Similarly, it can be used to connect as reader with a control panel with the help of wiegand-out interface. The operation can be done on the device through LCD display, also can be done on PC

software and uploaded to the device through TCP/IP, RS232/485 communication. It uses USB-host to download/upload data and provides simple user template and records. RFID device (SC403) is commonly used in offices, hospitals, industries, and houses. Figure 6 illustrates the connectivity of RFID device used for this application.

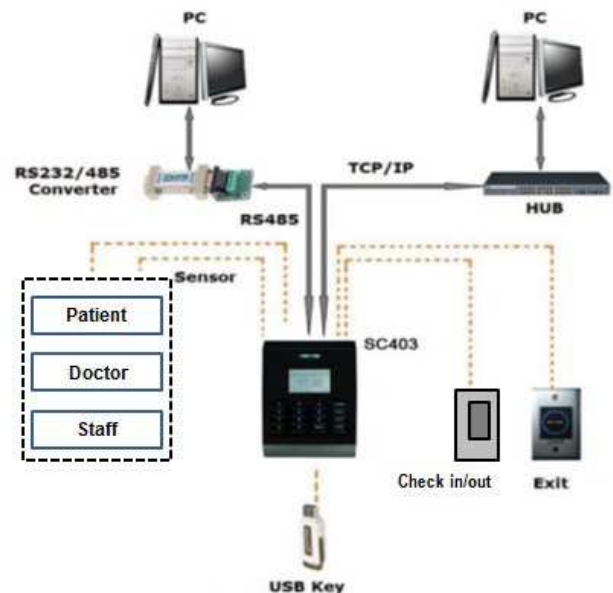


Figure 6. RFID Device Connectivity

The complete architecture of RFID based smart hospital system is represented in figure 7. The architecture is divided into three layers, user level where the users have the direct interaction with our systems through RFID connectivity and RFID tags are assigned to each class of users. Users may interact with PDA's, cell phones or PCs through application layer(web server) and connected to the database server, which stores and process RFID based (tagged) data in real time using standard query language interface. The central database is further divided into different data modules such as patients, doctors, staff, and treatment.

B. Architecture of RFID

- Our system will connect RFID through USB port.
- Our window form RFID box is connected with all field of database at backend.
- When RFID number shows automatically on RFID box through RFID device, all records will show on window form.
- The system records the location and time stamps of objects using readers to the database.
- The data warehouse can be used for data mining and knowledge based systems.
- The data flow of RFID based system is represented in figure. 8.

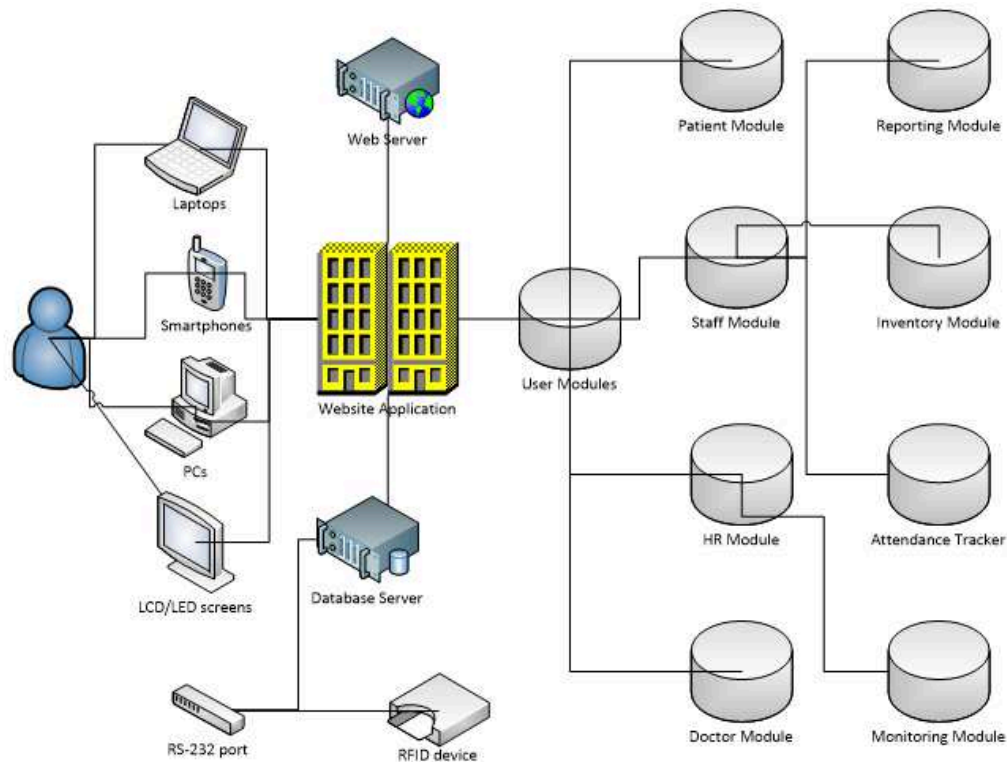


Figure 7. Architecture of RFID based Smart Hospital System

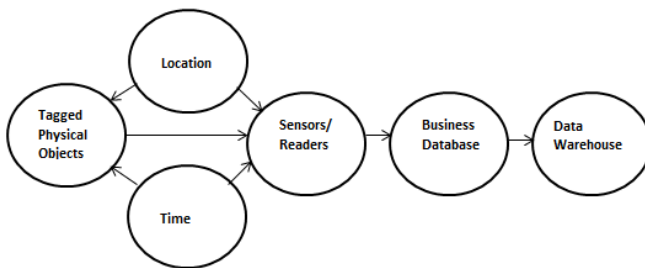


Figure 8. Data Flow in RFID

V. CONCLUSION AND FUTURE WORK

This paper highlights the importance of integration of ICT in healthcare domain. Our work is based on the application of RFID technology in healthcare sector that leads to the smart hospital concept. We have developed the database model (ER) for hospital system and integrated it with RFID technology. We have also presented the architecture for integrating RFID technology with hospital information systems. This proposed framework is more effective in providing up-to-date health information regarding patients as compare to the manual system where entries are being recorded manually. We have developed a working prototype application based on our model and will develop the complete system in future. The application is useful to minimize medical errors in contrast with the earlier manual data entry mechanisms. This work will be further extended to a complete system development, which will be deployed in real environment and a detailed survey may be conducted. Further, it can be extended to integrate mobile phone network with RFID technology.

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