HoMeTrack: RFID-based Localization for Hospital Medicine Tracking System

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***Abstract*—Miscommunication among physicians, nurses, and pharmacists can lead many medication errors. It should be eliminated and medicine information should always be verified. A good medicine management integrated with patient's medical records is an important thing to avoid medication errors. A proposed model of Hospital Medicine Tracking System using RFID technology (HoMeTrack) has been presented. The objective of this paper is to track the use of medicine based on given prescription and adjusted with patient's medical record in order to reduce medication errors. This tracking starts from the medicine out of the storage area until the medicine arrives at the patient. The prototype of HoMeTrack has been demonstrated by assigning RFID tags to medicines and by employing RFID reader along with web based system to track the use of medicines. Alert system will be activated if the medicines have been expired and stock of the medicines is at the minimum level.**

Keywords—hospital medicine tracking system; RFID; localization

I. INTRODUCTION

Healthcare sector is one of vital area in our life because it involves the safety of patients. Information and Communication Technology (ICT) has been growing rapidly and applied in various areas of society, including ICT for hospital services. A complex healthcare area requires appropriate the use of information technology and communication so that the medical process can run efficiently. Medicines are a major element in hospital services. The speed and accuracy of medicine delivery to the patient is the main factor in the quality of service. Utilization of ICT in the management of medicine in a hospital is capable to increase speed and accuracy of medicine delivery to the patient [1].

Many medication problems often occur in hospitals such as the slow response in the treatment to the patient and medication errors by medical personnels can cause fatal for the patients. The slow reponse in the treatment to the patient occurs because long medical procedures since ordering the medicines from nurse to the pharmacist, searching of the medicines in the pharmacy that should be adjusted with patient's medical record, till delivering process to the patient. Medicine management system that has not been integrated yet with patient's medical record can contribute to the medication errors.

Medication errors are unintended mistakes in the prescribing, dispensing and administration of a medicine that could cause harm to a patient. Medication errors that often occur in hospital such as delivering the unappropriate medicines to the patients and/or expired medicines. Medicine management information system in the hospital also needs to be improved, not only limited in the scope of the pharmacy, but also the medicine information system till to the patient as end user. Such model has not been widely explored and implemented. One of technologies that supports medicine tracking system is the technology of Radio Frequency Identification (RFID). Radio Frequency Identification (RFID) can be seen as one of the solutions that can be used to tackle medication errors. In this paper, a proposed model of Hospital Medicine Tracking System using RFID technology (HoMeTrack) has been presented.

The structure of this paper is as follows. Section 2 describes related works. Section 3 explains system design of HoMeTrack. Section 4 presents experimental results, whereas Section 5 is about conclusion.

II. RELATED WORKS

Applications using RFID technology in hospitals is relatively new compared to other sectors such as manufacturing, retail, library, logistics and supply chain. Many academics and practitioners believe that RFID technology has great potential to deliver benefits to the hospital. Reports of the RFID journal and Internet media showed that many hospitals in the world have implemented RFID technology and got benefit successfully from the application of this technology. It can be seen in the Netherlands, Italy and others [2-3]. Some hospitals have implemented RFID technology in the search area of the patient, medical staff, medical equipment and other application areas.

RFID system as a popular wireless communication technology has capability of identifying, locating and tracking living things and objects which is driven by the security

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features of the system. It has advantages in cost effectiveness, ease to use and implementation. RFID technology in pharmacies integrated with patient's medical record can provide a fast, efficient, and real time tracking in searching the medicines which is adjusted with patient's needs [4]. Healthcare applications utilizing RFID technology will lead to improve business processes such as the automation process which implicates to the reduction in manual process. The slow response in delivering the medicines and medical errors in medical administration can be reduced. By putting RFID tags on medicines, medical personnels can check whether the medicine is right and appropriate. It can improve medical care and patient safety.

Several previous studies have developed medical management system [5-11]. However there are some medication errors that have not been addressed yet. Capabilities of object localization or positioning are not normally included in an RFID technology [12-13]. One of the methods used for RFID based indoor localization is fingerprint method [14-17]. The basic principle of the fingerprint method is to find the location of the target by comparing its signal (or information) pattern with previously recorded database of known signal (or information)-location data. Previous researchers use several tags at specific location. The detected tags found by the reader at each location of interest are collected and from now on the detected tags are called a fingerprint. The location of the reader can be estimated using the intersection between the detected tags and fingerprints [14-15].

This paper presents RFID-based localization for hospital medicine tracking system that accurately determines the location of medicines. We use several RFID readers at specific location to monitor the RFID-tagged medicines.

III. System Design

Pharmacist gives tagging medicines with RFID tag stickers. Nurses give RFID tag bracelet to the patient. Patient's bed has own RFID reader. The nurses input the patient data and medication that will be given to the patient. Nurses deliver the RFID-tagged medicines to the patient. Once the medicines reach the patient, HoMeTrack will check whether this patient's bed is the appropriate patient. System architecture of HoMeTrack is shown in Fig. 1.

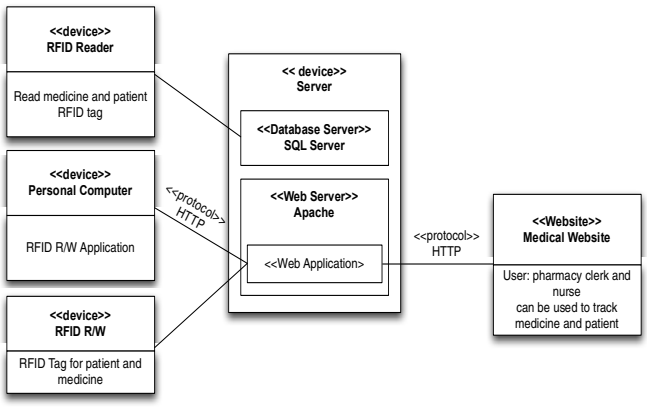

Fig. 1. System Architecture of HoMeTrack

In a whole HoMeTrack system, we use fingerprint method for localization technique to track the location of the medicine after being delivered from hospital pharmacy to the patients. Several RFID readers are placed along the corridors, patient rooms and other places in hospital. When the nurse walks along the corridors or room to room, the readers will receive radio signal from medicine tags and measure the signal levels of RFID tags. Readers send the information to server, and server process the information from several readers to get the location of medicine in real time.

HoMeTrack has five main processes as shown in Fig. 2, and is described as follows.

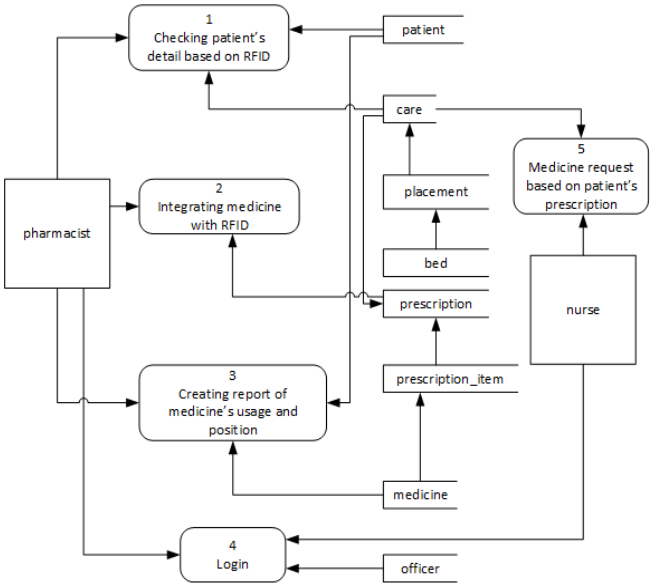

Fig. 2. Flow diagram of HoMeTrack

A. Process of patient data

This process occurs when a nurse came to the pharmacy to pick the medicines up. The nurse will scan the patient's RFID card on the RFID reader in a pharmacy. Desktop application for medicine tracking will show the information about the patient scanned (if the scanned RFID reader recognized by the machine). Patient information formed by patient table, care table, placement table, bed table, prescription table, prescription_item table and medicine table. The combined query of patient table, care table, placement table and bed table can result the information about patient's personal information, patient's care and patient's location. The combined query of prescription table, prescription_item table and medicine table can result the medicine needed by patient.

B. Process of integration RFID card to medicine

This process involves prescription table, prescription_item table dan medicine table. The card_number in prescription_item table will be filled by RFID number. The inventory of medicine will also be decreased according to the prescription.

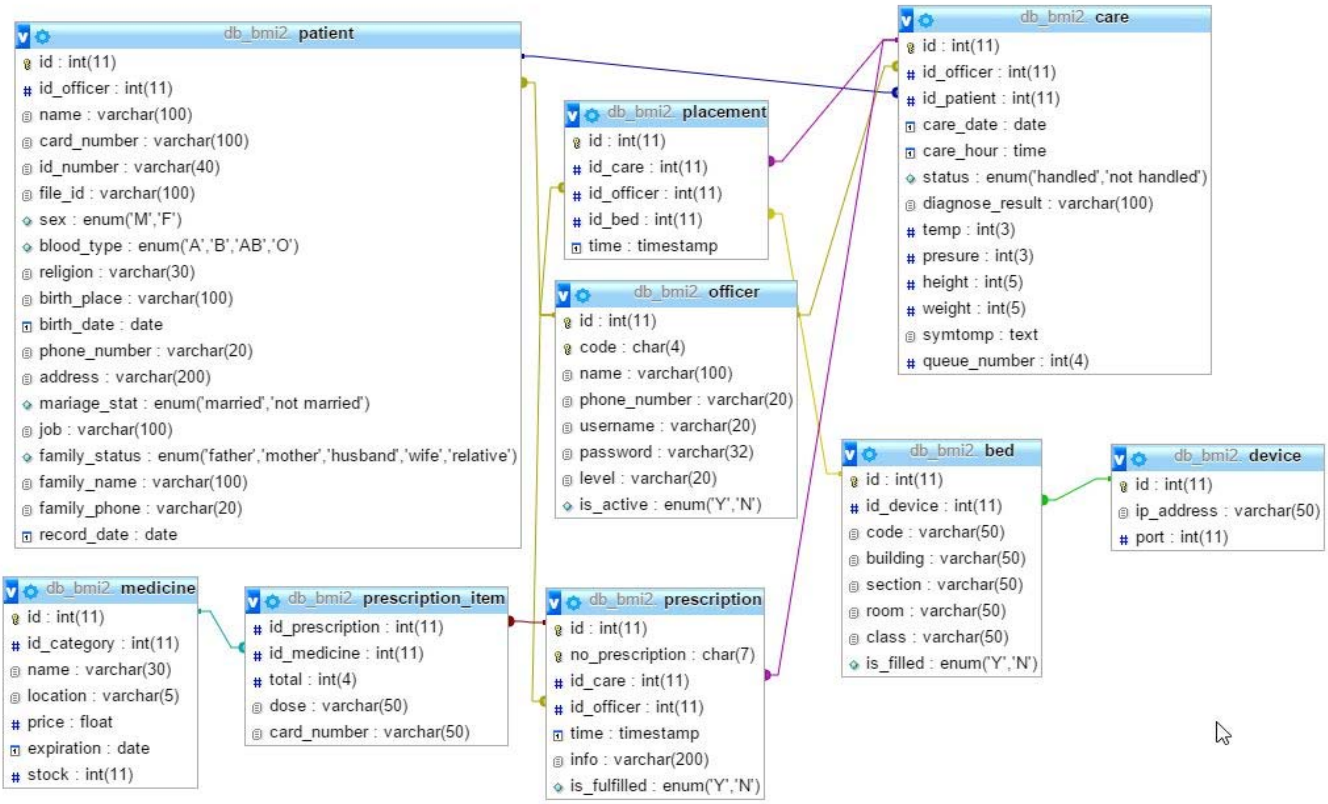

Fig. 3. Relational diagram of HoMeTrack

C. *Process of reporting for location tracking and the use of medicine*

This process involves the same tables as the process of patient data, but with different focus on medicine data. From query of patient table, care table, placement table, and bed table will produce patient data, care data, location and time of medicine delivery. From query of prescription will result prescription list, time and the responsible officer.

D. *Process of Login*

This process is for the use of user access, namely pharmacist and nurse. It only involves office table which contain login data and level of officer.

E. *Process of Medicine Application*

This process can be done only for nurse. It involves the same tables as the process of patient data, but focus on patient data.

Relational diagram of HoMeTrack is depicted in Fig. 3.

IV. Experimental Results

Experimental setup used in this research consists of:

- RFID access control, firmware version 6.60.
- MySQL Server 5.6.21
- VB.net using MS Visual Studio 2015 Community Edition

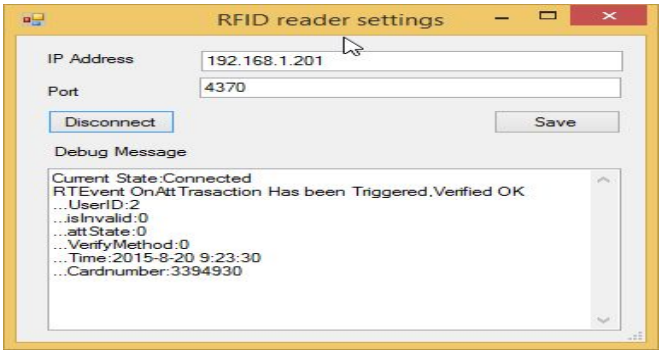

Fig. 4. RFID reader setting

Fig. 5. Integrating RFID to medicine

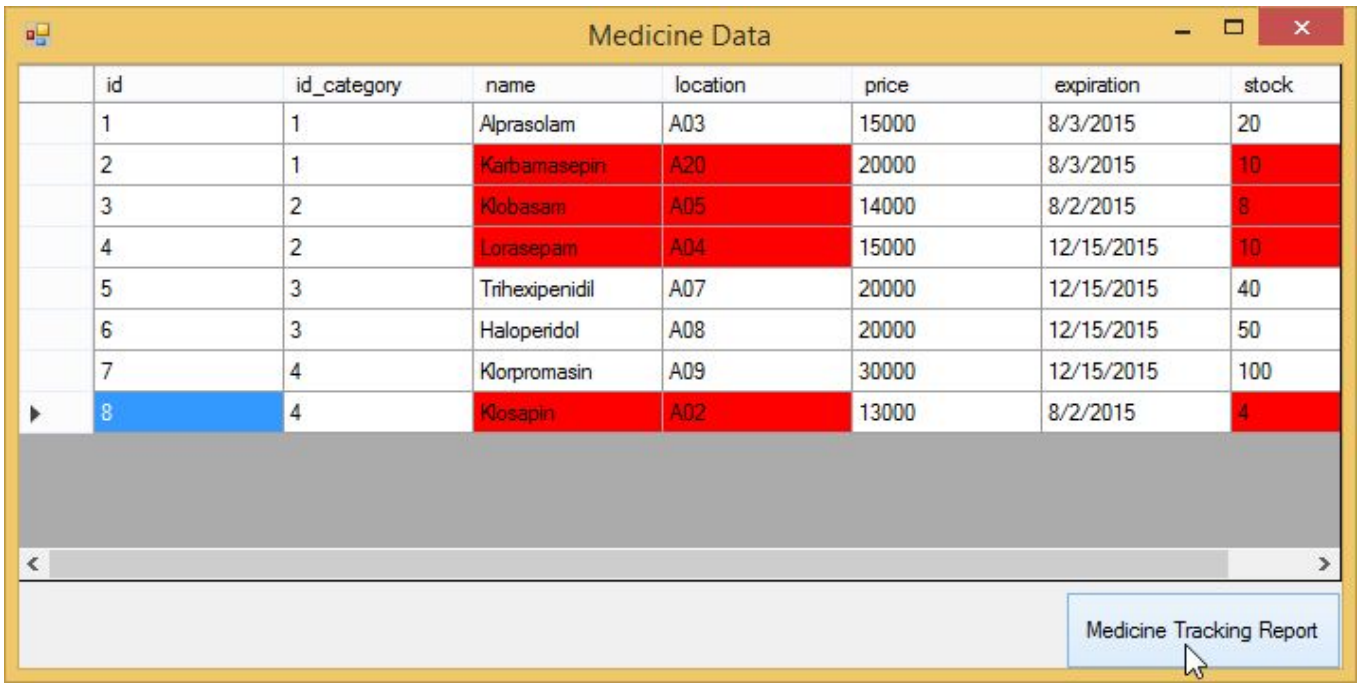

Fig. 6. Medicine data

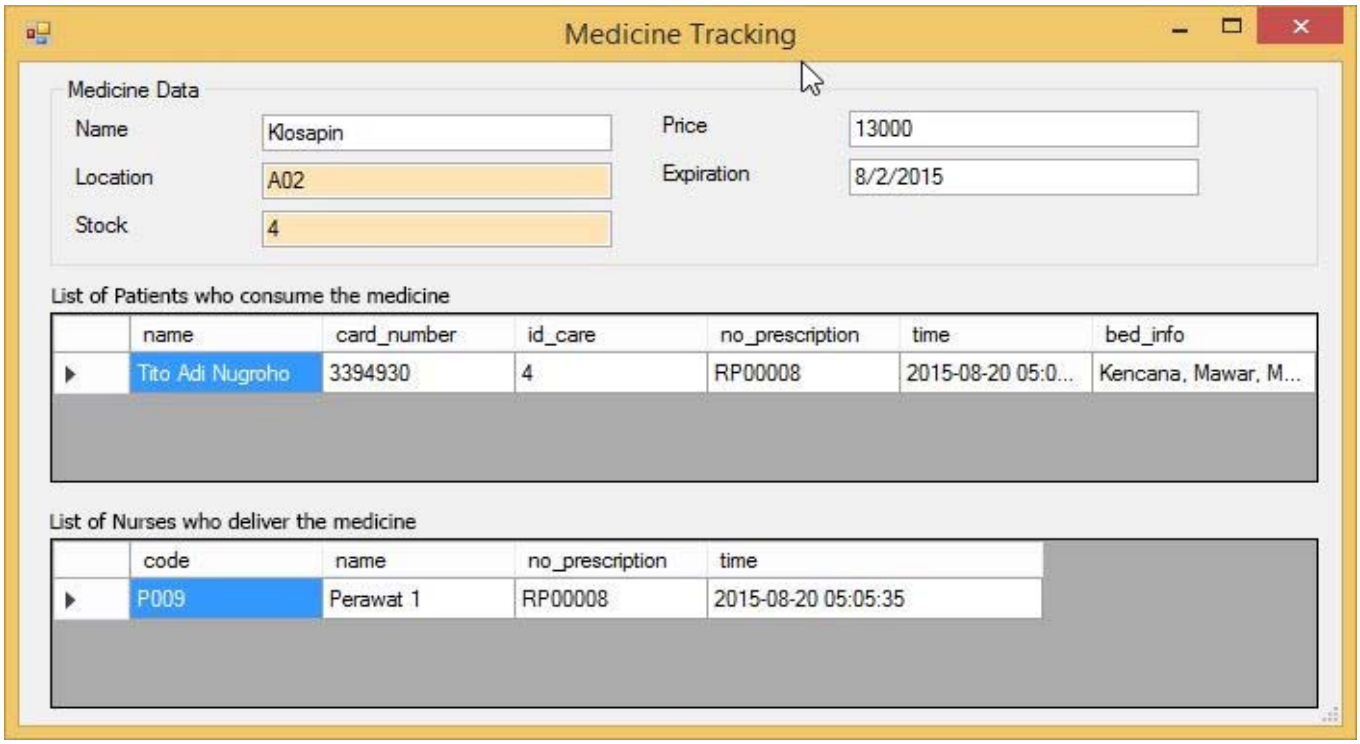

Fig. 7. Medicine tracking

IP address and its port are needed to test the connection to the machine. Fig. 4 depicts status of the system which is already connected to the device. When the system connects with the device, textbox "Debug Message" will contain data read by an RFID reader when the RFID card has been already successfully scanned (in the database engine). If the card which is swap is not in the database (rejected by the machine), there is no data appeared in debug message.

Each recipe can consist of more than one medicine. Fig. 5 will appear in several times according to the the number of

medicine type written in prescription. If the medications as written in prescription has been fulfill, MySQL database will reduce the medicine stock, and then this RFID data will be uploaded to the machine of RFID reader in patients bed. Medicines as written in prescription which have been integrated with RFID card will be given back to the nurse to deliver to the bed patient and will be scanned to ensure the correctness of the medicine. The pharmacist only need to enter the RFID number of cards (can be seen on one side of the RFID card).

The alert system of HoMeTrack will be activated into red colour if the inventory of medicine less than 10 items, as depicted in Fig. 6. The Fig. 7 shows the tracking report of each medicine. Pharmacist and head nurse can track the location of medicine, location of the patient's bed, the profile of patient who needs medicine, and the nurse who is delivering medicine to the patient.

V. Conclusion

We have demonstrated RFID-based localization for hospital medicine tracking system. Experimental results show HoMeTrack is successfully implemented by providing proper medicine management at hospital. Our system can be used for tracking both regular and emergency medicines. Future work includes integrating with patient's medical record and improving the localization accuracy of medicine.

Acknowledgment

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