

RFID Technology Combined with IoT Application in Medical Nursing System

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Abstract— In this paper, we design a Medical Nursing System which is based on RFID, WSN and NFC technology. For realizing Medical Nursing System, we visited Lotung Poh-Ai Hospital and a nursing home in Taiwan. There are five subsystems in Medical Nursing System designed for both nursing homes and the pharmacies. It is a system not only promoted the conditions in nursing home but also upgraded the accuracy of drug supply.

Keywords—RFID; WSN; NFC

I. INTRODUCTION

Technology makes our daily lives more and more convenient. We can see all kinds of electronic devices around us. One of the most popular technology is Radio Frequency Identification(RFID) which can be seen at door systems, visa cards and some hospitals using it. RFID is also marked as the top ten most valuable technology.

By the definition of World Health Organization(WHO), a society that has more than 7% of over sixty-five years old citizen is called an aging society. If it is beyond 14%, then the society is called an aged society. The number of Taiwan at 2011 is 10.8% which means our country is approaching aged society.

Because the approaching of aged society in Taiwan, we design Medical Nursing System and wish to reduce the burden of young ones. We use the RFID, Wireless Sensor Network(WSN), Near Field Communication(NFC) as our base technology. Through the architecture of Internet of Things (IoT), we expect Medical Nursing System can increasingly close to perfect..

II. OBJECTIVES

We hope that our Medical Nursing System can be close to the reality as much as possible. For realizing Medical Nursing System, we visited the Lotung Poh-Ai Hospital and a nursing home in Taiwan. The following is the problems which we found out at the hospital and nursing home.

A. Inadequate of Human Resources

There are 34 residents in the nursing home, but only 8 caregivers and 2 nurses in shifts. Although the provisions of nursing home fits the standards of the Government regulations. However, it is a manpower shortage situation for five caregiver to one resident according our observation. We expect that we can solve this problem by the help of technology.

B. Uncomfortable living environmental condition

The environmental condition of each room is different. For example, the temperature of rooms at western wide is higher because sun exposure is longer. This kind of the condition might be the cause of illness for the residents in nursing home.

Our solution is to control the environment of rooms such as temperature, humidity and lights. We expect that this solution not only makes the residents away from illness but also lives in a comfortable condition.

C. Emergencies

Although staffs control and monitor residents at the counter, the manpower shortage situation might cause tragedy. Most of time the residents will stay in door, but some residents will try to escape from nursing home. The issue is very dangerous and must be avoid.

D. Drug supply services for residents

The chronic prescriptions and health insurance cards were provided by resident's family. It is unified by the hospital that the cooperation pharmacy deals with drug-related matters. The steps of drug supply are as followed. First, the staff of the nursing home will take resident's health card and drug prescription to pharmacy and wait for apothecary to prepare the drugs. Second, the apothecary will give the drugs to staffs and take them back to nursing homes. Third, the drugs will be double checked by nursing home staffs. Finally the nurses will give the drugs to the residents at certain time.

The procedure of medicine delivery is very long, complex and unsure. There is a risk of staff took the wrong medicine to resident because not all the staffs in nursing home have the knowledge of medicine.

E. Hospital wards configuration

There is a equipment called "nursing cart" in Lotung Poh-Ai Hospital. It is for measuring patient's blood pressure, heart beat rate and other basic measurements. Nurse pushes the nursing cart to visit each patient's room at every regular time for basic biological signs measurement. Then nurse will check the patient's personal information by asking the patient's name or a glance of name card. After checking identity, nurse will give medicine to the patient which was prepared by other people.

III. LITERATURE REVIEW

We separate this section into four parts; the introduction of RFID, Wireless Sensor Networks(ZigBee), standard of Near Field Communication(NFC) and related work review.

A. Introduction of RFID

RFID is a built-in radio chip technology. Chips inside can store information such as product, location, date, personal data, etc. The size of a RFID card can be very small and attached to the objective that wishes to be recognized. It can also be embedded into the object which wishes to be track [3].

We have compared RFID and other electronic labels such as bar code and magnet strip card shown in Table I . Although RFID needs more cost to build but the efficiency is the most highest and relatively safest.[4]

TABLE I. Automatic Identification Comparing Table

Identify Technology	Bar Code	QR Code	Magstripe Card	Biological Identity	RFID
Memory	128 Bits	144 Chiastic	100 bits	No Memory	64-512 KB
Label Cost	Low	Low	Low	No Label	High
Equipment Cost	100-1000 USD	No Particular Cost	20-100 USD	More then 10000USD	10000 USD
Safety	None	None	Cannot Be Copied	High Safety	Encrypt Data
Recognition Speed	Low	Low	Low	Msec-Sec	Msec
Multiple Read	No	No	No	No	Yes

B. Wireless Sensor Networks(ZigBee)

IEEE (Institute of Electrical and Electronics Engineers) Standards Committee began a project on "Low Rate Wireless Transfer" at year 2000. The main purpose of this project is to develop a low cost, low rate, low power consumption for mobile or future use.

ZigBee hardware and software standards are developed by IEEE 802.15.4[5] and ZigBee Alliance. ZigBee support master-slave and peer-to-peer mode of operation and can

linked up to 255 devices with extremely high extensibility. The mainly use of ZigBee are in home-automation, environmental security, environmental controls, personal medical care. It has becoming a global industry of short-distance wireless communication technology.

ZigBee can be use on patients and facilities monitoring, not only can monitor physiological condition but also for positioning and tracking purpose. It is a perfect technology for clinical patients or Nursing homes.

C. Standard of Near Field Communication(NFC)

NFC is a technology which is based on RFID. It was developed by Philips, NOKIA and SONY due to the great future development of RFID and smart mobile devices. There are big number of operators that launch new NFC-enabled phone currently.

NFC is a short range high frequency radio technology implemented in 13.56MHz frequency within 20cm reading distance. There are 3 kinds of transmission speed of NFC which are 106 Kbit/second, 212 Kbit/second or 424 Kbit/second. NFC technology have become ISO/IEC IS18092[6] international standard, EMCA-340 standard and the ETSI TS102 standard. NFC technology uses two-way identification and has 3 working modes shown in Table II.

TABLE II. Working Modes of NFC

NFC Working Modes	
Card Emulation	In this mode NFC can emulate a RFID Tag. In this mode even if the mobile device is out of battery, the tag can still function.
P2P Mode	This mode is mainly use for data exchange. It has the advantage of high connection speed, low power cost.
Reader/Writer Mode	A NFC device can be use as a RFID reader through this mode. It can either read a RFID Tag or change the data which is already in the Tag.

D. Related work

The paper "Application of RFID Technology for In-House Drug Management System(2012)"[7] the authors has purposed a combination of RFID and medicine management. The benefits of using their system are first, every person in the house can collar the medicines at the right time. Second, if there are no User Tag people can still take their drugs but the system will automatically send emergency notification through GPRS and send message to the family. Third, when the drug box is running out of medicines, the system will mark the column of drugs in red so that people can resupply medicine.

Reference [8] is also an IEEE conference paper which is about a medical caring. In this paper the author has point out that although the technology growth is faster than we thought it would be. But at the domain of medical is relatively slow. In

this conference paper the authors has set up a scenario of hospital caring room. The use of RFID Ultra High Frequency (UHF) reader is to locate patients' position and the management of blood bags.

IV. RESEARCH METHODS AND IMPLEMENTATION

The system of Medical Nursing System is shown in Fig .1. We divided into five systems which include Identity Management System, Environmental Sensing System, Biomedical System, Medication System and Personal Orientation System.

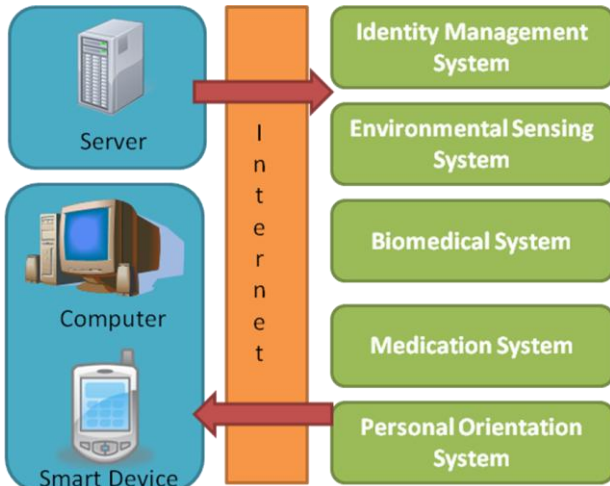


Fig . 1. Framework of Medical Nursing System

A. Identity Management System

All patients who needed to stay in the nursing home, the family will have to provide elder's basic information such as name, gender, photo and drug prescriptions. The staff will use the High Frequency(HF) Reader to create two cards, one is for identity and the other one will use in our Medication System. Identity Management System is a PC program written in Microsoft Visual C# shown in Fig. 2. Its purpose is to have a graphic user interface for inputting elder's data into computer and transmit all the information onto the cloud-server for further use.

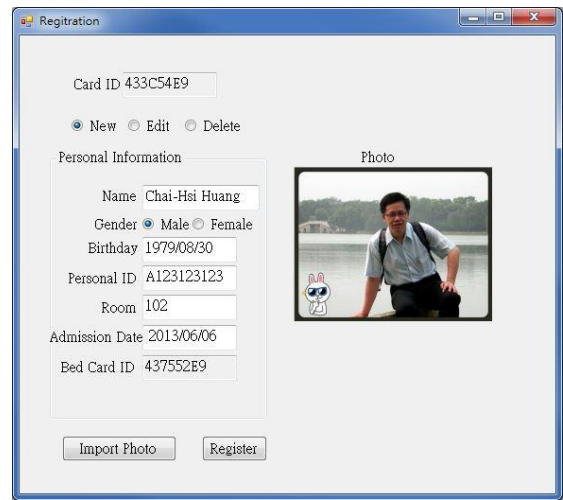


Fig . 2. Identity Management System

B. Environmental Sensing System

We will put three indoor ZigBee sensors which are temperature, humidity and brightness sensors in Environmental Sensing System. The purpose of this system is to improve all residents' living environment issue at the nursing home. The system is programmed to detect the sensor value at a certain number which is set up by the user shown in Fig. 3. Then Wireless Sensor Network(WSN) will transfer data through ZigBee protocol to the nursing home central PC computer. When the system receives the data it will transfers them on to cloud server and allows us to do the follow-up usage.

We can use a lot of ZigBee sensors in each space of the nursing home to achieve accurate sensing of residents' living conditions with temperature, humidity and brightness due to ZigBee is low-cost and low-rate. The central PC computer can have a defined value to control it. Whether decided to turn on heating, cooling, dehumidify-machine device or the increase/decrease of brightness to regulate the environment comfort.

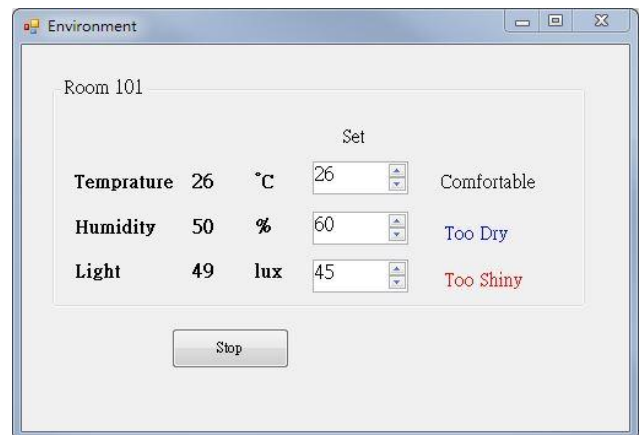


Fig . 3. Monitoring Condition of Room

C. Biomedical System

In Biomedical System we designed a MBS (Mobile Biomedical System) with the combination of Identity System to help nursing home staffs job easier. The system can sense variety values such as heartbeat, blood pressure, blood oxygen saturation(SpO2) etc. The data will be send through Bluetooth protocol to transmit all measurement into smart mobile devices and record it.

Whenever the nurse is doing resident's physical health check, it uses our MBS. First, the nurses needs to use NFC-mobile to sense the resident's bed card which is build at the Identity System phrase. This action is to inform the system which resident is to be measured. Second, at the measuring action, the nurse will just have to press the button at the application we wrote on NFC-mobile to active our MBS and start the measuring. The measured data will be transmitted over Bluetooth into mobile devices and will be display on smart devices screen shown in Fig. 4. After that, click the "Send" button, then the data will be passed through a wireless network to the server host.

We found out the inconvenient of nursing cart at the visit of Lotung Poh-Ai Hospital. The design of MBS is to solve this issue. As Table III shown, our MBS has the advantage no matter in the size or the way to operate.

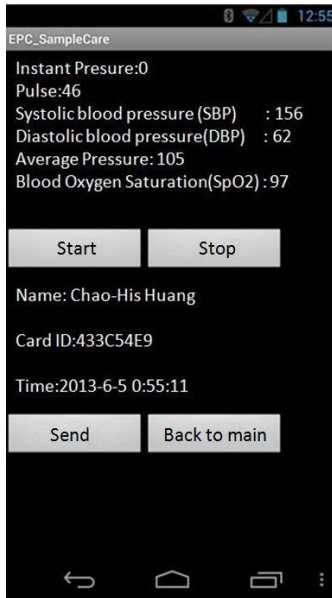


Fig . 4. MBS Measurement Result

TABLE III. Comparing Table of Nursing Cart and MBS

Nursing Cart	Compare Constant	MBS (Mobile Biological System)
Large	Size	Small
30 min.	Battery	6 Hr.
High	Cost	Low
Manual	Operating	Mobil Device
By Hand	Data Record	Wireless Portocal
Low	Interaction with Patient	High

D. Medication System

The reason we develop this Medication System is because we think there is a chance for a better condition about the drug control process and further developments at the nursing home we visited. We think it is better to separate the Medication System in to two parts which are pharmacy and nursing home:

1) In the pharmacy (pharmacy services):

a) Pharmacy staff input the information such as indications, side effects and entities picture of drugs into the database shown in Fig. 5. Its purpose is to convenient the follow-up operations.

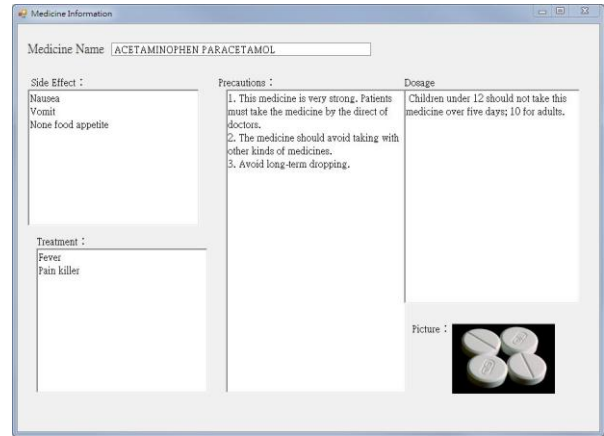


Fig . 5. Inserting Data into Medication System

b) The staff will have to choose the drug datas from the list which have been entered in to computer at phrase a for each resident seperatly and save it shown in Fig. 6. At this phrase the main purpose is to bond the drug prescription and the resident.

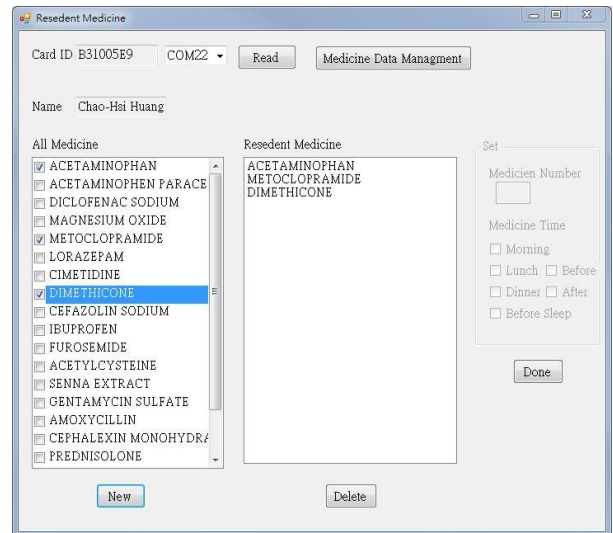


Fig . 6. Choose Drugs

c) When pharmacy staff finished packing the drugs and set up the drug information system a HF Tag must be written

with datas. All the data will be sent to the server and the drug bag with a HF Tag will now wait for the nursing home staff to collect.

2) *In the nursing home:*

a) After the drug bag have taken to the nursing home. The nursing home staffs have to verify all the drugs by scanning HF Tags.

b) When it is drug dispensing time the nurse will use NFC-mobile to sense on resident's bed HF Tag. The NFC-mobile screen will display the resident's name and photo with the drugs name, pictures and informations about how the resedent should take the drugs which is shown in Fig. 7. These information are for nurses to determine if the drug they brought for resident is correct.

c) Nurse needs to click upload button on the mobile screen after finished drug dispensing. The system will send a completion time of medication onto cloud database as a record. The information which has uploaded to the cloud server is also useful for later on checks.



Fig . 7. After Sensing The Bed Card

E. *Personal Orientation System.*

The escape of resident will be a serious threat to their safety. This system is mainly design to prevent this tragedy. When the staff is too busy and didn't notice the residents has escaped from their rooms of nursing home. The system will sound the alarm to inform the staffs.

The UHF Reader is placed at each resident's room door. With the EPCglobal organizational forms UHF Class 1 Generation 2 Tag and its unique tag identification to identify the residents. When resident leaves the room the computer will

send out a message to inform staffs as Fig. 8 shown. This is how our Personal Orientation System works with run-away possibility.

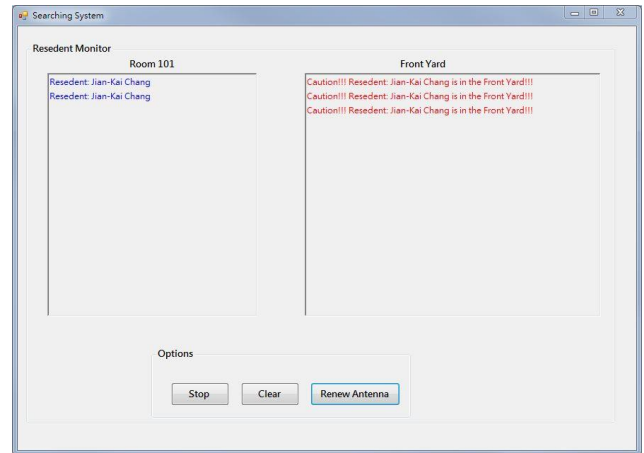


Fig . 8. Personal Orientation System

V. CONCLUSION

We found out the problems in the nursing house and hospitals by our visits. In this paper we designed a system which can improve the awful situations. Our Medical Nursing System have five main systems: Identity Management System, Environmental Sensing System, Biomedical System, Medication System and Personal Orientation System. Each system can work not only individually but also interactively.

Our system design is based on the architecture of IoT. We use RFID, sensor, WSN in Identify layer and use 2G/3G, Wi-Fi, ZigBee and Bluetooth to transfer the data. We expect our design to achieve Intelligence Medical Care.

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