DESIGN OF A WIRELESS PATIENT DIAGNOSIS SYSTEM

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ABSTRACT

Medical administrative and diagnosis procedures require the retrieval of patient diagnosis history before treatments and drug administration. This involves careful checking of the patient past record which might be stored electronically or in paper files. This process is tedious, time consuming and often prone to error. The need to reduce error in patient administrative and diagnosis process has result in wide-ranging research work to integrate latest technology into health care system. Hence, the need for an automated system, that can display patient diagnosis record from a storage location to a care giver without any human intervention. This paper describes the design of a wireless patient diagnosis system (WPDS) for retrieving patient medical diagnosis history. A DLP-RFID1 Read/Writer with ISO 15960 tags were linked together in a novel way using LabVIEW solution that integrates MS Access database for storage and retrieval of information.

Keywords RFID, LabVIEW, database, wireless network, health care

1 INTRODUCTION

RFID is an emerging technology that has been successfully applied in supply chain management, manufacturing, and logistics, but its range of application extends far beyond these areas. There is tremendous potential for applying it even more widely, and increasing numbers of companies have already started up pilot schemes or successfully used it in real-world environments.(Heinrich, 2005). RFID areas of application includes: Animal detection, Aviation, Building management, Construction, Enterprise feedback control, Fabric and clothing, Food safety warranties, Health, Library services, Logistics and supply chain management, Mining, Municipal solid waste management, Museums and Retailing. (Violino, 2005; Laurie 2005; Claudia and Claudio , 2008; Amato-McCoy 2008; Mark et al 2007).

RFID technology had been deployed in health care to improve safety of life's and equipments. (Beth, 2007; Claire, 2010) RFID technology is creating enormous security solutions for tracking and reduction of theft (drugs, chemical, equipment, and babies) in medical world. (Heather 2005; Proxima RF, 2010). It had also successfully been used for monitoring of medical samples and blood, to detect changes in quality and quantity during transportation and storage. The existence of RFID technology in health care makes it important to integrate this technology into patient record administration to completely eradicate human error in diagnosis. The WPDS system will increase patient safety by reducing human error caused by manual cross-checking of patient files for diagnosis, drug prescription and administration. With a sensor IC that communicates with passive high frequency (HF) RFID, sensors can be read with desktop or handheld units or draw power from OEM equipment. Thus, a customised RFID reader could be integrated into hospital devices to ease the task of patient diagnosis.

2 DESIGN AND ARCHITECTURE

2.1 WPDS Architecture

The WPDS architecture comprises of an RFID tag and reader, middleware, computer hardware, and a database as shown in Figure 1. The patient medical history and present medical situation are linked to a unique tag allocated to them. Thus, a health care giver will only have to visit a patient's bed side or consulting room with embedded RFID reader in a mobile PC. All the patient information will automatically be loaded on the screen. This includes: patient's medical history and present symptoms; his temperature; blood pressure; drug administered and the exact time he/she was last checked. An update will be made were necessary and saved back to the database.

A unique UID is attached to individual patient information in the database. The database could be local or in a remote location. The RFID reader reads the tag and send the information to the middleware through some protocol, the middleware process the tag and translate it to machine code that can be understood by the PC. The portable PC (e.g. Ipad), accesses this information and sends it to the database and vice-versa.

2.2 WPDS Design

The WPDS data acquisition and processing has five components as shown in Figure 2. The patient's UID is read by the RFID reader. The reader sends the UID to the middleware. The PC uses the middleware to query the database and display the information for viewing and updating.

ISO 15963 Tags

An RFID tag consists of an integrated circuit attached to an antenna. The tag antenna used in this project, is in the form of conductive ink "printed" on a material that allows for connection to the integrated circuit. This type of passive (battery-free) tag is commonly referred to as an "inlay". An AC voltage is generated in the antenna whenever a radio frequency field passes through the tag's antenna; this generated voltage is rectified to supply power to the tag. The tag can then be able to receive commands from the reader after being powered. This will allow the information stored in the tag to be read by the reader and sent back to the host PC for processing. The data in the tag consists of a hard-coded, permanent serial number (or UID) and user memory that can be written to, read from and locked if desired. Locking the tags makes it impossible to change the data on the tag. Though, data can still be read from the tag.

DLP-RFID1 Read/Writer

An RFID reader (or "interrogator") in Figure 3 is typically a microcontroller-based radio transceiver that powers a tag with a time-varying electromagnetic radio frequency field. The DLP-RFID1 is a USB-powered device for reading from and writing to ISO 15693 RFID transponder tags. It has the ability to both read (frequency of 13.56MHz) and write up to 256 bytes of data with the addition to reading the unique identifier (UID/SID). The DLP-RFID1's electronics and antenna reside within the compact unit, and all operational power is taken from the host PC via the USB interface. It has a permanent Unique Serial Number which is accessible via USB, and an integrated Pass/Fail Beeper. The internal antenna has a read range of up to 4 inches depending upon the size of the tag being read.

2.3 Software Selection

Various programming languages had been used in the past to develop RFID applications. However, LabVIEW has been chosen for the implementation of the WPDS because it is a graphical development environment with built-in functionality for simulation, data acquisition, instrument control, measurement analysis, and data presentation. LabVIEW offers a flexibility of a powerful programming language without the complexity of traditional development environments. It delivers extensive acquisition, analysis, and presentation capabilities in a single environment, allowing seamless development of a complete solution on a platform of choice.

2.4 Microsoft Access Database with LabVIEW

LabVIEW Database Connectivity Toolkit contains easy-to-use function libraries for performing database operations within LabVIEW without SQL programming. It provides an alternative method for creating a framework to manage test data using recorded information. Thus, database toolkit makes it easier to store and retrieve test information, compare actual results to historical data, and document a large series of different tests.

3 WPDS IMPLEMENTATION

An Access database was created and linked to LabVIEW with Microsoft Jet 4.0. Two tables were created in the database: **Profile Table** which contains all the patient basic information and **Diagnosis Table** containing the patient diagnosis history. The implementation was broken into different modules called sub.vi. A detailed explanation of all sub.vis' is not explained in this paper due to space constraint.

3.1 Patient_Management_System.vi

This is the main sub.vi as shown in Figure 4. It is used to retrieve information from remote access database to LabVIEW front panel on a PC. This is done by reading the Unique Tag Identification (UID) from the DLP-RFID1 read/writer and using the read string to query the required table (Profile or Diagnosis) from the database. The information that matches the UID are uploaded to the corresponding LabVIEW indicator arrays and then output to the user interface.

3.2 Configuring the DLP-RFID1 for ISO15693 Operation

The DLP-RFID1 is configured for ISO15693 by using command 0x10 to write to the register. Below is a command that describes the register write request operation and shows the request/ response from the DLP-RFID1 device.

>> 010C00030410002101000000

<< 010C00030410002101000000

Register write request.

The “>>” indicates a request string and “<<” indicates a response string. The above request writes to the register to set up ISO15693 protocol. The DLP-RFID1 is now configured to accept ISO15693 commands.

3.3 Response Codes

Below is the request and response for the inventory command.

The request/response for an Inventory command with 1-slot is:

>> 010B000304142401000000

<< 010B000304142401000000

ISO 15693 Inventory request.

[2680C2E5D2C407E0, 6C]

This shows that tag “E007C4D2E5C28090” responded, extracts and appends [inside square brackets] to the response.

3.4 Read_tag Sub.vi

This sub.vi is use to configure and read the serial port. It is also used to send command protocols to the DLP-RFID1 reader/writer. It enables the bytes at port to be read with the VISA read tool to a string indicator. The VISA Configure Serial Port (baud rate, data bits, stop bits and flow control) is used to initialize and configure the com port for LabVIEW to communicate with the USB DLP-RFID1 device as shown below.

4 RESULTS

The WPDS system was evaluated using test data for the two mode of operation – viewing and updating the patient diagnosis records. The LabVIEW interface displayed a patient diagnosis history depending on the tag in the reading range of the USB device. This information was viewed in view mode or updated in update mode. Whenever the database was updated, the patient diagnosis information changes, as well as the date, time and room where those changes took place. The new record immediately becomes available for viewing, as shown in Figure 6, in subsequent tag and reader interactions.

Thus, information on the interface, changes whenever there is a change in the patient information from the database. Different ISO 15963 tags were tasted with the application and the interface remain blank whenever a tag that has no reference in the database is brought close to the application.

4 CHALENGES OF RFID

The security, privacy, and integrity of the RFID system are significant issues to consider. In particular, as a wireless technology, RFID poses potential security concerns to users when the communication between the tags and the reader is exposed to eavesdropping and traffic analysis. Security concerns might arise regarding data compromise during wireless transmission, the storage of data, and the physical security of storage site (Kwang et al, 2010). Health care applications may be particularly vulnerable to security risks, because a variety of external entities might have access to the tags or related databases (Sabbaghi and Vaidyanathan, 2008).

A study by Wu *et al.* (2006) explored the existing risks and obstacles to facilitating a quick adoption of RFID. These risks can be grouped into several categories, such as technology risks, standard risks, patent risks, costs risks, infrastructure risks, return-on-investment (ROI) risks, and barcode to RFID migration risks.

People may also take a long time to understand and trust the technology because it is relatively new to them (Lee *et al.*, 2007; Ngai *et al.*, 2007); creating relative concerns to privacy issues. Concerns over privacy will significantly delay the acceleration of patient level tagging. In addition to privacy concerns, cultural adherence can affect the relationship between patients and medical officers, environmental constraints, lack of technology awareness and level of education.

5 CONCLUSIONS

RFID is one of the fastest growing technologies in the world. It is predicted that, by the year 2016; all health care facilities would have been automated with RFID technology. Creating a system where every individual will have a hospital identification card with a unique RFID tag embedded into it - a world of embedded systems in wireless network technology. This paper presents the results of our research work on RFID components, its applications and challenges of the technology in health care; as well as, the design and development of a wireless patient diagnostic system (WPDS) that is ubiquitous, safe, reliable and easy to use.

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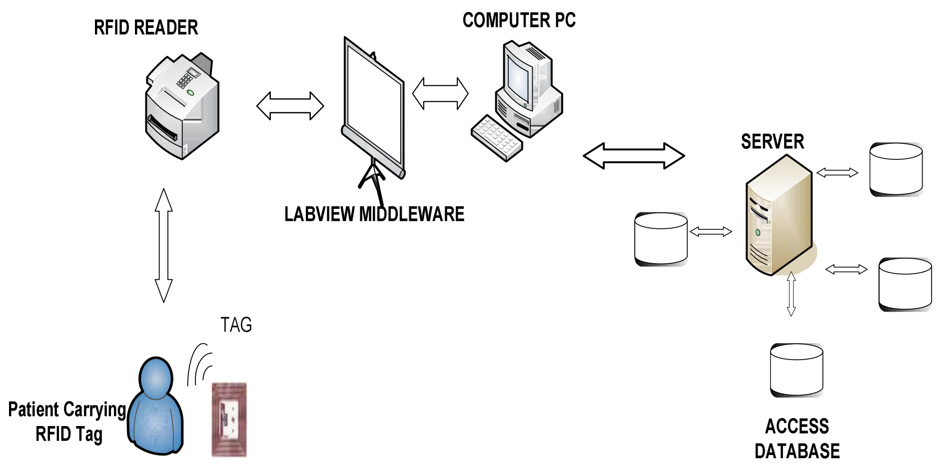

Figure 1: Architecture of Wireless diagnoses in Health Care.

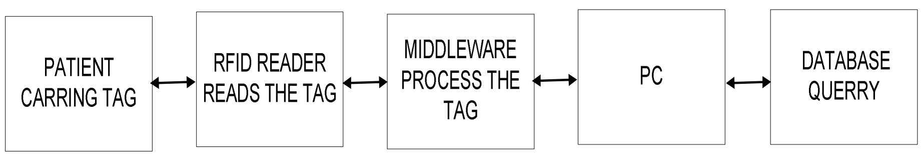

Figure 2: Block Diagram of Design

Figure 3: Image of a DLP-RFID1 Read/Writer

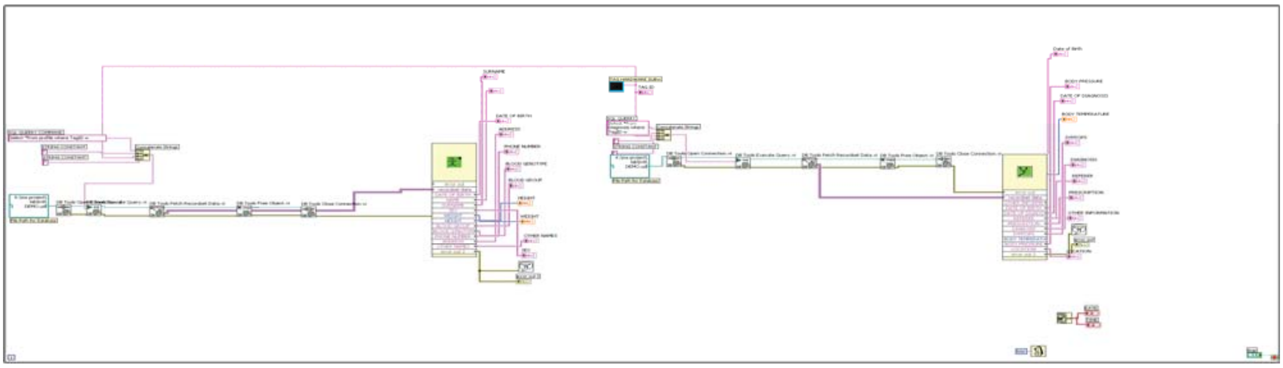

Figure 4: Patient_Management_System.vi

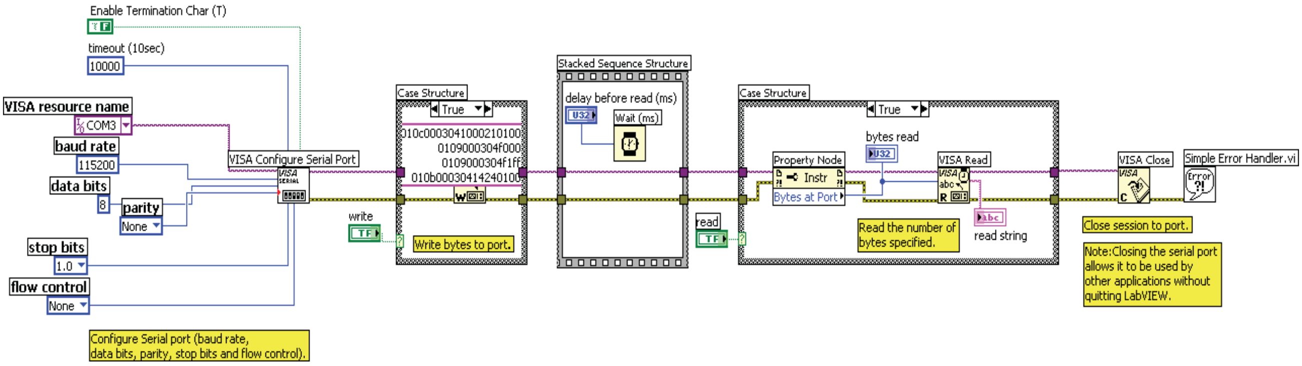

Figure 5: Read_tag Sub.vi

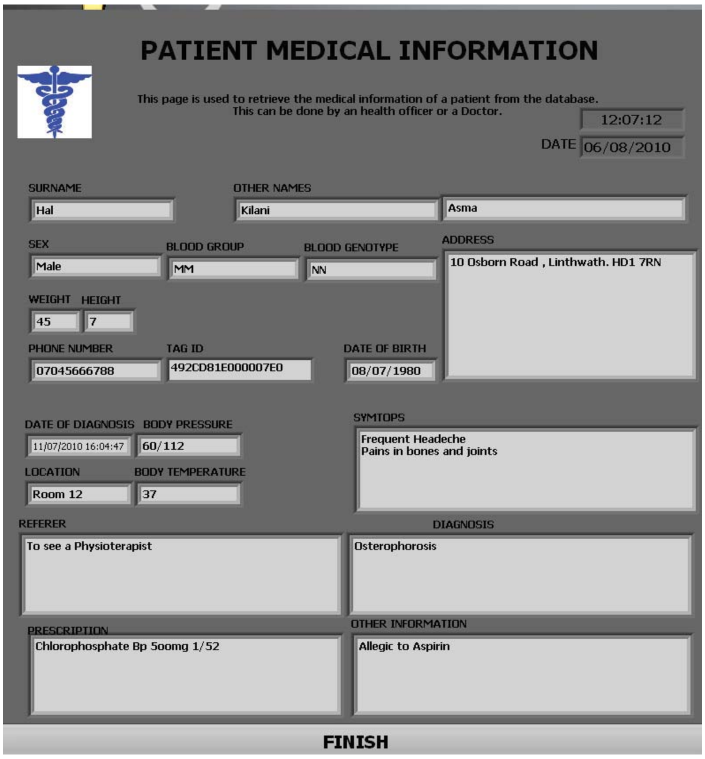

Figure 6: Image of the User Interface