

A Portable Wireless System for Identifying Orthopedic Implant with RFID Tag

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Abstract— A method of making an interactive medical implant identification device with a radio frequency identification tag mounted on an implant, the tag being covered with a liquid impermeable seal. The identification of the RFID tag using Touch probe operating at a frequency of 125 KHz is directed towards the integration and the management of medical information. This is comprised of labeling the medical device with a radiofrequency identification tag and maintaining a medical product database which associates the information, including manufacturer, type of implant, composition of implant, dimensions and measurements of implant, date of implantation, patient information database including patient name, address, medical history and any other type of data that may be beneficial, with the specific tag identification for use by the physician. Interaction of signal from the reader with the PC and the database in visual basic software is done by Zigbee technology.

Keywords— *RFID, Tag, Implant, Zigbee, Visual Basic*

I. INTRODUCTION

An implant is a device surgically placed into the body designed to restore function by replacing or reinforcing a damaged structure. Orthopedic implants can be defined as medical devices used to replace or provide fixation of bone or to replace articulating surfaces of a joint. The surgical procedures for each implant involve pull out the damaged joint, provide with an internal fixation and an artificial prosthesis replacement. Among the most common types of medical implants are the pins, rods, screws and plates used to anchor fractured bones while they heal.

The material used in orthopedic implants must be biocompatible to avoid rejection by the body and hence they are mainly made from stainless steel and titanium alloys for strength and lined with plastic to act as artificial cartilage. Other risks associated with orthopedic implants include implants coming loose or breaking in the bone causing painful inflammation and infection to surrounding tissue.

II.MOTIVE OF THE PROJECT

Orthopedic implants not only give back quality of life but also help in increasing mobility and reducing pain. Each orthopedic implant is designed to correct the affected joint so that it withstands the

movement and stress associated and to enhance mobility and decrease pain. The total number of knee and hip replacement surgeries per year keeps increasing in the recent years and will hit 3.48 million in 20 years [2]. However, once the implant replacement surgery is finished, doctors and surgeons have difficulty to observe and obtain the detailed information of the implant. If the patient is unconscious after any accident, we need to retrieve the information about the patient and implant. Most hospitals use paper based archives to keep the patient history whose management is a huge cost. It takes much time to search for the implant and patient information, which does not only increase the risk of mistakes but also increases the cost. The main motive is to provide an efficient and accurate way for orthopedic implant identification to reduce time and cost. In order to accomplish this, a method of using radio-frequency identification (RFID) technology for orthopedic implant identification is done. Our project's aim is to provide more, exact implant information and improved data acquisition regarding the implant and to improve the access and control of critical medical information.

III.SYSTEM DESIGN

RFID (Radio Frequency Identification) is a technology that incorporates the use of electromagnetic or electrostatic coupling in the radio frequency (RF) portion of the electromagnetic spectrum to uniquely identify an object or person. Radiofrequency identification tags can be read through aqueous environment of the human body. RFID of implantable medical devices is to facilitate increased efficiency and productivity and of related patient information. The method is directed towards for integrating labeling of implantable medical devices and management of medical information comprising the steps of labeling the medical device with a radiofrequency identification device and maintaining a medical product database which associates the information, including product identification after implantation, recipient medical identification, storage and dissemination of product processing information and product quality assurance, including verification of manufacturers and original equipment, date of implantation,

expiration date if applicable, type of instruments

required for removal of implant and any other type

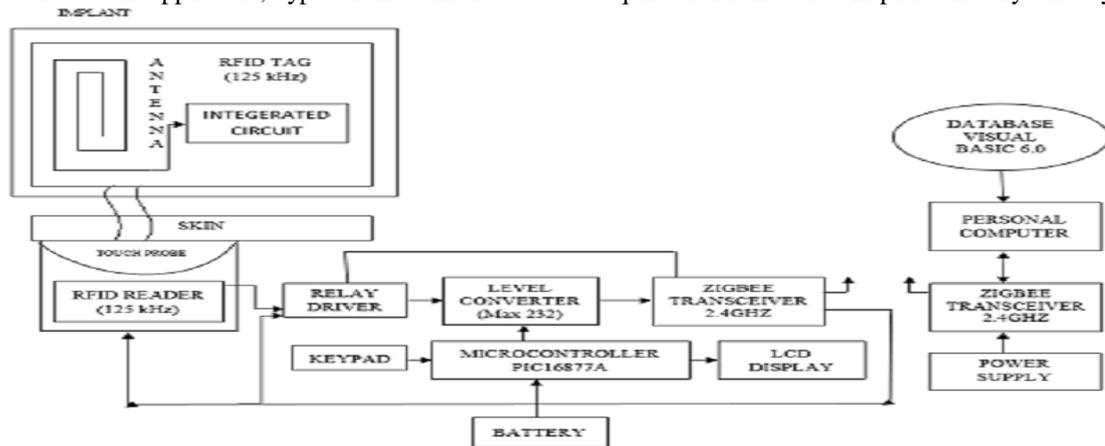


Fig.1 Block Diagram of the system

of data that may be beneficial, with the specific tag identification for use by the physician. This is also directed toward a medical implant with an RFID tag and/or patient information database including patient name, address, and medical history, treating physicians and institution, implanted device history.

Zigbee supports advanced sensor networks and RFID is suitable for low-power wireless tracking of objects. By combining the two technologies, it is possible to create a Zigbee mesh network with integrated active RFID tracking capability. With Zigbee, the read range of the RFID system was enhanced the transmitting capability via mesh routing, which allows data packets to traverse multiple nodes in a network to route data from any source to any destination, it provides the approach to avoid collisions between readers and extends tag life times in the process. Visual Basic is an event-driven programming language from Microsoft. It also contains an integrated development for developing GUI applications. The use of Visual basic in our project includes Interfacing of signal with PC and storage and display of Implant and patient details after matching the code from database.

IV. SYSTEM DESCRIPTION

A. Power Supply

The battery used in our project is sealed lead-acid rechargeable battery. This provides regulated power to the power supply module. The power supply module supplies power to relay circuit, Microcontroller and Zigbee at the transceiver side for making the project as a portable one. The power supply unit consists of a transformer, rectifier, filter and regulator. The designed circuit converts the standard 230 V, 50 Hz, ac signal available into a

constant dc voltage. The AC mains supply passes through an isolating switch and safety fuse before it enters the power supply unit. The high voltage mains supply is too high for the electronic circuitry in the project. It is therefore stepped down to a lower value

by means of a Transformer. From the transformer the AC voltage is fed to a rectifier circuit consisting of one or more diodes. The rectifier converts AC voltage to DC voltage. This DC is not steady as that

from a battery because it is pulsating. The pulsations are smoothed out by passing them through a smoothing circuit called a filter. The filter consists of capacitors and resistors. IC 7805 is a 5V fixed three terminal positive voltage regulators IC. IC 7805 regulates the filtered output to produce a steady 5Volt DC. Thus the regulated constant output can be obtained for the operations of Microcontroller, RFID reader used in this project.

B. Signal Acquisition Using RFID System

1) *RFID Tag*: An RFID tag is an electronic device with data storage and the ability to reply to an electro-magnetic stimulus generated by a reader. It composed of a miniscule microchip and antenna. The electronic chip acts as a principal element, which is controlling the communication with the reader. The energizing and communication between the reader and tag is accomplished through antenna coils. When activated, the tag transmits data back to the antenna. The RFID reader can be read from a distance, right through skin, clothes and hence data is read from the RFID tag placed on the implant for the purpose of our project. The RFID tag consists of unique ID for each tag. It contains a section of memory functioning to store the identification codes or other data the memory

being accessed at the communication time. RFID tags are virtually impossible to copy. The response of a passive RFID tag used in our project is by an identification number.

2) *Touch Probe with RFID Reader:* Touch Probe is the Plastic case which contains the RFID reader is shown in the Fig 2. This is for easy handling. The touch probe should have a proper size so that it can fit onto the knee area of an adult person. This Touch probe will send the RF signal from the reader to the human body and receives the tag data and send to the controller.

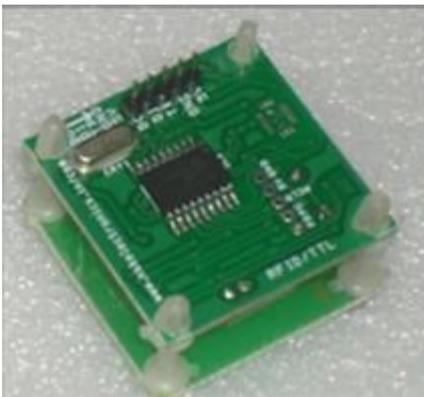


Fig.2 RFID Reader 125 kHz

The RFID Reader is an electronic device able to generate an electro-magnetic field, following a defined protocol that is able to transmit and receive information to and from the transponder. This features a receiver/transmitter module with antenna and a male connector that enables connection with development systems. The operation of the RFID reader is based on amplitude modulation of radio waves and electromagnetic induction. This RF reader module with an internal antenna facilitates communication with Read-Only transponders via the touch probe interface. The RFID Reader emits a low-power radio wave field which is used to power up the tag so as to pass on any information that is contained on the chip [1]. In addition, readers can be fitted with an additional interface that converts the radio waves returned from the tag into a form that can then be passed on to another system, like a computer or any programmable logic controller.

C. Signal Processing

1) *Microcontroller:* Microcontrollers will combine other devices such as a timer module to allow the microcontroller to perform tasks for certain time periods and a serial I/O port to allow data to flow between the controller and other devices such as a PIC or another microcontroller. It also combines with an ADC to allow the microcontroller to accept analog input data for

processing. Micro controller is a standalone unit, which can perform functions on its own without any requirement for additional hardware like I/O ports and external memory. The microcontroller that has been used for this project is from PIC series. PIC microcontroller is the RISC based microcontroller fabricated in CMOS that uses separate bus for instruction and data allowing simultaneous access of program and data memory. The main advantage of CMOS and RISC combination is low power consumption resulting in a very small chip size with a small pin count. The main advantage of CMOS is that it has immunity to noise than other fabrication techniques.

2) *Level Converter:* The main purpose of this converter is to convert the TTL logic to RS logic. MAX 233 is level converter IC which is used to make logic compatibility between TTL and RS232 logic. The often only the TTL voltage levels are available ,but for the communication with RS232 standard one needs voltages of +12V and -12V .A separate supply voltage would be a high amount .MAX232 needs only one supply voltage of 5V .It generates itself the level of +10V and -10V . This converter is located between the PIC microcontroller and the Zigbee module, the microcontroller uses TTL logic whereas the Zigbee module uses RS logic.

D. Signal Transmission

The transmission of the signal occurs from the tag to reader in the form of encoded data. The data is then transmitted through Zigbee module in the transmitter side to the receiver side and database corresponding to the tag ID number is send back via the same path.

1) *Zigbee Module:* Zigbee reader performs the collection command every one second with a read range to 100 ft. The extended coverage and effectively improved reliability of Zigbee can dramatically improve the read performance of an RFID system. Hence in this project we use Zigbee reader to send out tag information with a minimum interval time as short as 200ms. The Zigbee protocol provides a great deal of flexibility and stability for an RFID system by finding alternate routes to transmit data if there is a node down or obstruction blocking its line of sight[4].

2) *Relay Circuit:* A relay is an electromagnetic switch. It is activated when a current is applied to it. Normally a relay is used in a circuit as a type of switch. There are different types of relays and they operate at different voltages. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between

control and controlled circuits), or where several circuits must be controlled by one signal. In our project, at the transmitting side, when the keypad is pressed controller makes the relay ON, signal from the reader is sent to the PC via Zigbee. At receiving side, when the keypad is again pressed, controller makes the relay OFF, signal from PC is sent to Portable unit via same Zigbee.



Fig 3. Zigbee Transceiver

E. Database Using Visual Basic

Visual Basic provides many interesting sets of tools to aid us in building our project. Visual Basic is an event-driven programming language from Microsoft. It also contains an integrated development environment for developing GUI applications. Visual Basic enables the rapid application development (RAD) of graphical user interface (GUI) applications, access to databases using Data Access Objects, Remote Data Objects, or Objects. Visual Basic also has the ability to develop programs that can be used as a front end application to a database system, serving as the user interface which collects user input and displays formatted output in a more appealing and useful form.

A VB Program is made up of many subprograms, each has its own program code, and each can be executed independently and at the same time each can be linked together in one way or another. In the front end form is designed using intrinsic controls according to the need of project. In back end algorithm for form is written. Once the code is read from the com port, VB displays the form with implant information and patient details for the respective code from the database. This database contains the following information such as X-ray image of the bone before implantation, name, date of surgery, DOB, gender, blood group,

surgery type, nature of work, RFID Number, Hospital name, place, plate dimension, general surgeon, and details of implanted device history.

F. Information Display in Portable Unit

The LCD display (16x2 LCD) which can be interfaced with Microcontroller can display information. LCD display can be used to obtain the important details required as soon as the ID number from the RFID tag is read.

V. CONCLUSION AND FUTURE WORKS

The RFID reader reads the tag ID at 125 KHz from the RFID tag placed on the metallic implant with a buzzer sound. The ID number is displayed on the LCD display as soon as the tag is read. Zigbee transceiver sends the ID number to the Visual Basic program which displays the whole patient database at the same time. This information can be displayed in the LCD which is controlled by the keypad. Thus this RFID system helps to retrieve information without using paper archives and patient reports.

The future works can include the system with a sensor for monitoring the implant condition after surgery. The database should be centralized to use all over the world which enables the doctors to retrieve data even if the patient is unconscious.

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