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MEDICAL HISTORY TRACKING AND TOKEN GENERATION USING IBUTTON AND ZIGBEE PROTOCOL

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Abstract-

The medical world is compacting everyday as the technology and research improving for the welfare of human beings. The medical records of any patient suffering from severe diseases need to be carefully handled and to be stored for future reference. The medical record database system needs more attention to improve its portability and security for such applications. The medical history tracking was useful for electronic medical record system as it includes both features viz. Secure and portable. iButton is the hardware key provided to patient for accessing their medical record by themselves, doctors and insurance companies. The system was implemented on embedded platform and ARM7 as its processor unit. The system is useful in big organizations where the data storage is a critical job and the portability of record is time consuming. Another system of token generator was developed to solve the problem of queue waiting in hospitals and huge organizations for treatment. The token is generated which have printed information like name of consulting doctor, running token number, total token number, time required for check-up etc. This token system will help to update and print the running token number of patient. It saves the time of patient as required time for check-up is printed on the token, so queuing problem automatically solved. The status update of patient is communicated using ZigBee wireless network. The doctors from different department update their statuses using respective iButtons over the ZigBee network. Both systems are very useful in huge organizations and hospitals. The system can be made available for animal husbandry and defence personnel for whom handling of medical record is one of the critical jobs. The system can be upgradable to other applications with minor changes in the circuits of medical history tracking and token generation systems.

Index Terms— Electronic Medical Record (EMR); iButton; ZigBee; Touch-Screen; token generation;

I. INTRODUCTION

Today the world is compacting as the numbers of technologies are replacing the older methods of operations. From different engineering application fields, medical field is the critical one as it deals with the life of human beings, so more attention is needed for this field. When the patient visits any hospital, doctor or consultant needs a previous medical record of the patient for proper treatment. But sometimes, patients were unable to produce these records on time to the doctor due to some reasons like forgetfulness, unavailability of records and some mishaps. Mentioned reasons may create problem for the doctor for proper check-up and treatment of the patient. Paper-based records are still by far the most common method used for recording patient information in most hospitals and practices worldwide. The medical record is to be preserved for number of years based on the treatment. The records are stored at different locations within the hospital, so the collection of record is another time consuming process. These records are not immune to parameters such as ageing, wear and tear, fire, humidity *etc.* Handwritten paper medical records can be associated with poor legibility, which can contribute to medical errors.

The medical records are very much important for the patients suffering from severe diseases as they have to take care of each and every prescription and test results for future reference and treatment. This problem is also observed in case of huge organizations or hospitals where these records are to be preserved. The work was developed to avail the medical history of the patient anytime and anywhere in the hospital for the reference of doctors. The previous information of the patient like when the patient visited for last check-up, information

about his medicinal course etc. will be made available in fraction of seconds on computer screen. Here the medical history tracking of the patient was done using iButton (1-Wire Technology) and the record was stored in the database server. It was continuously updated after every visit of the patient to the hospital. It has the ability to exchange records between different organizations or hospitals (interoperability) that would facilitate the co-ordination of healthcare delivery in non-affiliated healthcare facilities. In addition, data from an electronic medical record system can be used anonymously for statistical reporting in matters such as quality improvement, resource management and public health communicable disease surveillance. A token system was developed which generate a token from the counter having current patient number, name of the consulting doctor, time of appointment, name of the department, name of the hospital etc.

II. Applications Based On iButton, ZigBee And EMR

Different technologies in the domain of identification are available such as barcodes, magnetic stripes, chip cards, RFID tags *etc.* To these technologies a new technology is added called iButton which is based on 1-wire technology. An iButton is a micro-system having two external wire connections *viz.* signal and ground.

One of the researchers developed an application based on 1-wire technology in combination with hardware and software [1]. The application is basically developed for identification and authorization of iButton on the 1-wire network and it is also used for 1-wire network interrogation and data processing. Here, DS9090 and its graphical interface were used for developing a prototype. The software includes different functional switches for interrogating the devices present on the 1-wire network. The application is basically developed for the iButton devices such as addressable switches and also temperature sensor devices. The conclusion is made that the iButton devices were ideal for applications where information is to be transmitted by means of an object or a person. The application developed can be useful at the intelligent buildings for monitoring and control of different parameters. The different domains also suggested for the 1-wire network such as meteorology, parameter control in embedded systems, vehicle security, banking applications, sensor networks *etc.*

Another approach based on the 1-wire technology is presented in one research. Here, data logging system and stock management system in the warehouses were developed using the 1-wire technology [2]. Each and every container in the warehouse is affixed with a small electronic tag (called iButton). The tag keeps all the information of the container such as storage loading and unloading history, goods contents, ownership, *etc.* Another iButton identified as location tag is placed in every storage cell. An iButton is similar to RFID tags but it is immune to electro-magnetic interference, signal distortion and absorption that happen in case of RFID tags and its reader. The conclusion is made that this data logging system based on iButton technology and 1-Wire communication protocol is more useful and simple as compared to conventional storage and stock management systems.

In field of wireless technologies, ZigBee is one of the economical and low power consumption technologies. Different applications were developed for the purpose of communicating within the network. Shyr-Kuen Chen *et al.* developed ZigBee based patient monitoring system for detecting the fall of the patient in the hospital [3]. Here, the ZigBee protocol is used to transmit the emergency messages of the patient to the concerned person in the hospital. The network is divided into three main nodes as it is a three hop ZigBee network. These nodes are sensor, router and receiver. The sensor node which is mobile in nature senses the signals from the patient and sends to the nearest router. Router routes those messages to the receiver. The ZigBee protocol is used for forwarding the data packets, which transmits the emergency messages with vital signs on a multi-hop network with multiple data receivers. Hence, the conclusion is made that the scheme is fast and reliable and can be employed on wireless WAN or WiMAX to achieve real-time patient monitoring. The 4G technology can replace the present technology for improving the transmission latency.

A network repair scheme is proposed in a study [4] for the data collection applications in ZigBee wireless sensor network. The network repair scheme is divided into two sub-schemes; regular repair and instant repair. The regular repair scheme refreshes the network periodically to maintain the proper shape of the network and deals with two stages *viz.* tree reformation and slot assignment. While the instant repair scheme have extra address space for routers, so that a new path can be selected during failure and deals with localized reconnection and address update. Also two theorems were stated and proved for the proposed scheme. The conclusion is made that the scheme slightly increases the converge-cast latency and the instant repair scheme has fault tolerance capability. Also the scheme maintains the network during frequent link failures.

An application was developed by D. Leonard and A. Pons for identification of patient medical records using biometric technology [5]. For migrating the medical records from paper form to electronic and it can be made available anywhere in the world within fraction of seconds. Fingerprint, iris, retina scan and DNA are four basic and unique biometric functions used to form a framework called FIRD. These components are unique for each person and hence used for identifying the healthcare information of the patient. This healthcare record system will be beneficial over older methods where patients were identified by their medical record numbers in an organization. This medical record number system is useful only in the same organization and the record number

varies from organization to organization. Hence, the conclusion is made that the biometric identifier system is unique and accurate as compared to older techniques. This technology will help to make available the medical record in less amount of time anywhere in the world, as it can be accessed from internet. The main function of this system is to identify the patient and its record accurately using the FIRD framework.

III. SYSTEM DEVELOPMENT

The medical history tracking system was similar to Electronic Medical Record system as it deals with the storing and accessing the medical record of the patients. Different applications are developed and made available to store the medical records safely and can be accessed any time in the world. Many countries like U.S., Taiwan, and Bangladesh *etc.* have developed their own EMR systems and are compatible with the other EMR systems in the world for the interoperability. In such countries medical records are having the utmost importance to handle the medical record of a patient for long period of time. In similar way, the medical history tracking system was developed to handle the medical history of the patient. Here, an iButton (1-Wire Technology) was used as an authentication key to access and update the medical record of the patient.

Another application of this work was medical token generator system. The token was generated to give the detail of the visited patient waiting in a queue for treatment. The system was associated with ZigBee wireless module for updating the current number of the patient from medical professionals of different departments. The status was updated using iButton given to physician of each department and it was wirelessly sent over the ZigBee wireless network. It also has the touch-screen user interface for generating the token through printer.

A. Medical History Tracking

The medical history tracking was basically the system used to authenticate the medical record of the patient and can be made available at anytime and anywhere in the organization. An ibutton was the main authentication device used to track the medical history of the patient. It provides the basic information of the patient that includes

- Name of the patient
- Age
- Sex
- Last Check-up Date
- Previous Prescription
- Current Prescription
- Consulting Doctor

Every iButton is having its own unique 64-bit ROM number lasered during its manufacturing and it cannot be changed. So to make unique hardware access system for medical record each patient was provided with a separate iButton for their identification.

Figure 1. Proposed Block Diagram of Medical History Tracking System

The ibutton was used to read the medical history of the patient from the data server. The reader reads the ibutton, which gives the access to the data on the server related to the patient to whom the ibutton belongs and it is shown in Figure 1. This was a secure data access system. After every visit of the patient, his medical records were updated on server by the technical staff of hospital. The ibutton of particular patient gives access to the data of that patient only. Hence, when the patient gives his ibutton to doctor, then and then only doctor can access his data. So doctor can update the record by himself or by technical staff in the hospital.

B. Medical Token Generator

The medical token was generated using the ZigBee wireless protocol and printer with respect to the status updated from different departments on the wireless network.

Whenever any patient accesses the touch-screen, the updated data was printed on the paper (token). This updated token has following data printed on it:

- Name of the hospital
- Name of the department
- Name of the consulting doctor
- Current number of the patient

- Total number of patients
- Estimated time for check-up

The current status of the patient was updated by the doctor of respective departments by using their respective ibuttons. A simplified block diagram of medical token generator is shown in Figure 2.

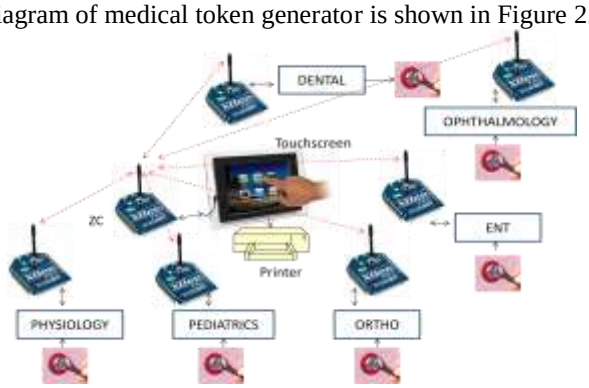

Figure 2. Proposed Block Diagram of Medical Token Generator

Every physician from different department has their own iButtons for updating the status of visiting patient waiting in a queue for treatment. The status can be updated on the network using the ZigBee wireless module communicated within the line of sight range. The updated status can be printed on the paper using thermal printer connected at the touch-screen terminal.

C. System Prototype

The hardware implementation of the system is shown below. The medical history tracking system was associated with processor, an iButton reader, RS232 serial port and ZigBee module.

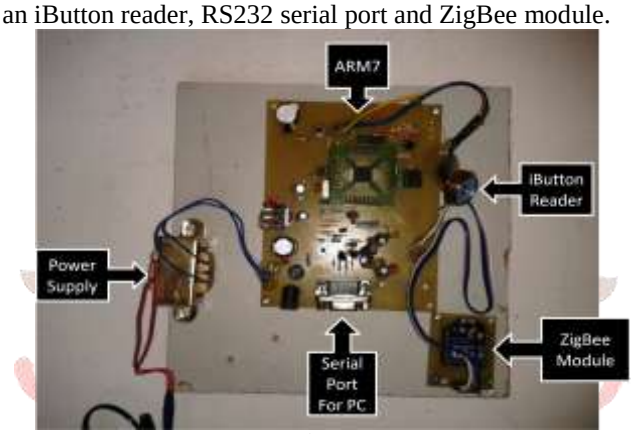

Figure 3. Hardware Arrangement of Medical History Tracking System

The representation of medical record on computer screen is shown in Figure 3. In the snapshot, first line will show the message of system initiation on computer screen. When the iButton of any patient was read by the reader it will display the information on computer screen (see Figure 4). After check-up, doctor will update the status on ZigBee wireless network by touching respective iButton to the reader and a message of status update will appear on the screen.

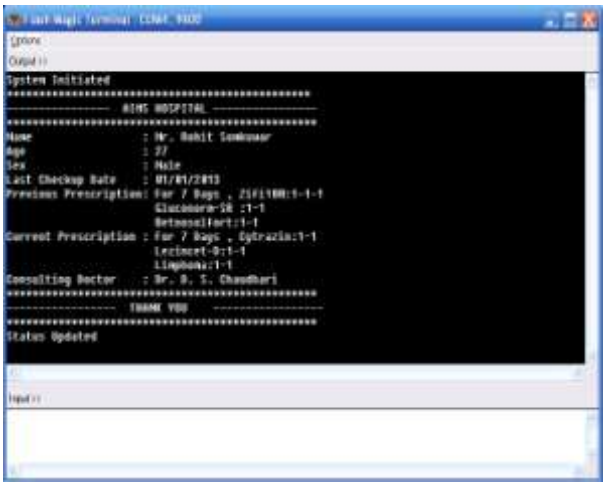

Figure 4. System Initiation, Medical Record and System Update

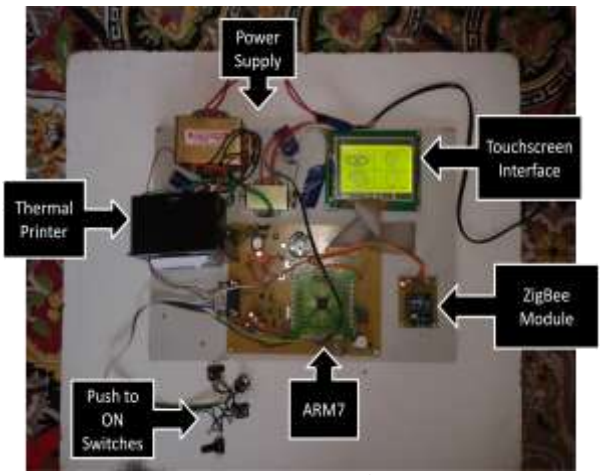

Figure 5. Hardware Implementation of Token Generation System

The complete hardware implementation of medical token generator is shown in Figure 5.

IV. PERFORMANCE ANALYSIS

Token generator system was used to indicate the current status of the patient. The system was developed to solve the problem faced by patient came to hospital for their regular check-up and have to stay in a queue till announcement of their number. Here, a token was generated which gives the printed information regarding the status of the patient such as running token number, total token number, estimated time for check-up and name of the consulting doctor. This will solve the problem of queue waiting.

Different tokens were generated with and without updating the status of the patient and samples of tokens are shown below.

(a) (b)

Figure 6. Token for Status Updated One Time

When the two tokens are generated and third token is to be generated, in between this Doctor completes his check-up with first patient and updates his status on the ZigBee network (Figure 6.a). So the third token generated with an updated status have the running token number decremented by 1, so running token and total token number are printed as 002 and 003 respectively (Figure 6.b).

The ZigBee wireless module used in this work was to establish the communication between token generator system and different departments. The status of patients is updated periodically by the physicians. The XBee module developed by Digi International was used for this communication. The ideal range of communication for this module is 30 m (indoor) and 90 m (outdoor) at line of sight. The range of this module was tested in different condition and observed the effects of physical parameters. Following were the different results obtained during testing. The line of sight range of XBee module after testing was found as 30 m. After this distance the module will loses the communication with another module.

Table I. XBEE MODULE RANGE TESTING (30 METER)

Distance between TX and RX (in meter)	Obstacle	Path Loss (dB)	Successful Transmission
30	No obstacle	-69.7	Yes
30	Wooden Block	-93.6	No
30	Glass	-95.6	No
30	Human Body	-98.1	No
30	Metal	-103.1	No

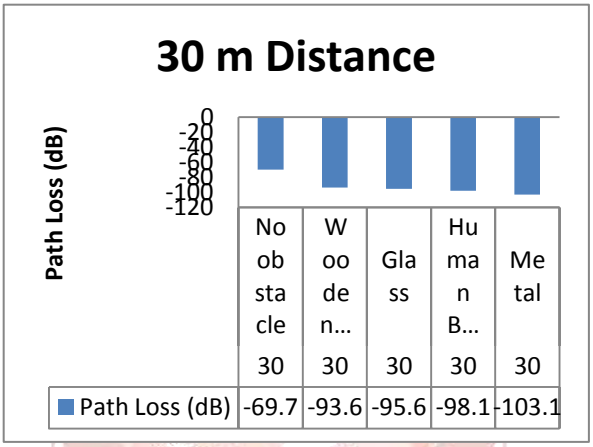

Figure 7. Path Loss at 30 meter Distance

From the Table I it was clear that the range of XBee module goes on vanishing as we add the different obstacles in line of sight communication (See Figure 7). The metal body was more affective to the range of XBee module compared to other mentioned obstacles.

V. CONCLUSIONS

An electronic medical record (EMR) system is implemented in different developed countries and it is in demand due to its availability of records and interoperability with other EMR system. The medical history tracking system is a part of an EMR system where it will provide an access to the medical record of any patient with valid hardware key (iButton) only. The system will be very useful to the doctors, for the proper treatment of the patient as it provides complete medical information of the patient. It is also useful to patient, as there is no need to carry their documents with them for every visit to the hospital. They can access their medical records online in the future when the system will be implemented worldwide and connected through internet. Without iButton of the patient no one permitted to access the medical record of respective patient. The system will provide higher security to their personal medical information as compared to other EMR systems. Only the loss of iButton will create the problem to the system. But iButton can be moulded in different daily use ornaments such as wrist watches, rings and key-chains.

The token generator system will be helpful for solving the queuing problem in hospital during the treatment and it will be a time saving application for the patients. The time will be saved which was earlier wasted during their treatment while standing in a queue. So the medical history tracking system will very useful for the doctors and patients both, and the token generator will be useful for saving the time of the patient.

REFERENCES

E. Diaconescu, C. Spirleanu, "An Identifying and Authorizing Application Using 1-Wire® Technology", *16th IEEE International Symposium for Design and Technology in Electronic Packaging*, 2010, pp. 243-248.

K. Tee, M. Chew and S. Demidenko, "An Intelligent Warehouse Stock Management and Tracking System based on Silicon Identification Technology and 1-Wire Network Communication", *Sixth IEEEInternational Symposium on Electronic Design, Test and Application*, 2011, pp. 110-115.

S. Chen, T. Kao, C. Chan, C. Huang, C. Chiang, C. Lai, T. Tung and P. Wang, "A Reliable Transmission Protocol for ZigBee-Based Wireless Patient Monitoring", *IEEE Transactions on Information Technology in Biomedicine*, Vol. 16, No. 1, 2012, pp. 6-16.

M. Pan and Y. Tseng, "A Lightweight Network Repair Scheme for Data Collection Applications in ZigBee WSNs", *IEEE Communications Letters*, Vol. 13, No. 9, 2009, pp. 649-651.

D. Leonard, A. Pons and S. Asfour, "Realization of a Universal Patient Identifier for Electronic Medical Records Through Biometric Technology", *IEEE Transactions on Information Technology In Biomedicine*, Vol. 13, No. 4, 2009, pp. 494-500.