Internet-Of-Things Based Intelligent Home-centric Healthcare System

Shiny Prakash S.J\(^1\)
\(^1\)Anna University, Department of Electrical and Electronics Engineering, shinyprakash91@gmail.com

K.Sekar\(^2\)
\(^2\)Anna University, Department of Electrical and Electronics Engineering, kosekar_2007@yahoo.in

Abstract— In recent years, the world is facing a common problem that the number of elderly people is increasing. Hence providing In-Home Health Care Services for elderly people is very important. The medication non-compliance problem has caused a serious threat to public health. Wireless sensor networks are now being widely used to structure home health care systems. Here, an Internet-of-Things (IOT) based intelligent home centric health care system has been proposed which connects smart sensors attached to human body for physiological monitoring and intelligent pharmaceutical packaging for daily medication management. The proposed system involves three key blocks: Biopatch, a wearable biomedical sensor used for acquisition of biosignals, iMed Box which serves as gateway to gather patient’s physiological information and provide a variety of medical services and iMed Puck, an intelligent medication administration system for timely delivery of medication to patient. Thereby this system provides remote prescription and medication non-compliance services. The medicine deficiency datas are send to the doctor’s mobile instantly using android application, once the medicine are insufficient over there. Representatives of the hospital are send to fill the medicine in the medicine box. This proposed Home-Centric Health system brings about ubiquitous and personalized healthcare.

Index Terms— Medication management; Internet-of-Things(IOT); Wireless sensor network; In-Home Health Care Services

1 INTRODUCTION

The next generation form of health care has been recognized to be the Pervasive health care services to home environment. Hence the presently followed traditional hospitalized, staff centric and professional managed care can emphasize on an alternative of distributed, patient centric, and self-managed care. This system is designed based on Internet-Of-Things (IOT) which is based on extending internet into our everyday lives using wireless links. One of the killer applications of the IOT of the so-called Health-IOT in which pervasive health care is based on the emerging technologies of Internet-Of-Things [4]. The medication non-compliance service has caused a huge financial waste worldwide and has also caused a serious threat to public health as well. In order to meet the rapidly increasing demands for daily monitoring, on-site-diagnosis and prognosis an in-home healthcare solution (IHHS) is becoming essential.

An intelligent iHome Health IoT system which is a home based platform has been proposed and implemented which provides a preventive and pervasive medication management solution based on intelligent and interactive packaging (iMedPack) and intelligent medicine box (iMedBox). The Bio-Patch is the wearable biomedical sensor enabled by the state-of-the-art system on chip and inkjet printing technology. The intelligent medicine box has the feature of interchangeability and enhanced connectivity for integration of devices and services. The intelligent pharmaceutical packaging with actuation capability is enabled by functional materials and communication capability enabled by passive radio-frequency identification (RFID) [5]. The proposed platform fuses IoT devices with in-home health care services such as Telemedicine for an increased service efficiency and improved user experience. This newly emerging e-health monitoring system provides for personalized medication management, real time monitoring and acquisition of vital signs, seamless health care in comfortable home environment and this system greatly reduces the total expenditure on medical care and treatment.

1.1 The Health IoT Platform

The Internet of Things (IoT) is an integrated information network of future internet which connects a large number of information and communication systems, in which people interact with information and communication technologies. The ubiquitous and personalized in-home healthcare (the so called Health-IoT) enabled by IoT technology is a promising solution for both traditional healthcare industry and will speed up the transformation of healthcare from career-centric to patient-centric. This system has the following functions:

- **Tracking and monitoring:** All objects powered by ubiquitous identification, sensing, and communication capacity can be tracked and monitored by wireless sensor network devices.
- **Remote service:** Self assist and healthcare services such as telemedicine, medication management, first aid, emergency...
detection etc can be delivered directly through internet and field devices.

1.2 Intelligent Pharmaceutical Packaging
The Intelligent pharmaceutical packaging has offered a technical solution to achieve the so-called preventive medication management. This packaging interacts with patients by integrating RFID, sensing, communication, display, and other functions onto traditional packaging. It is an intelligent medication administration system for the timely delivery of medication to the patient. The intelligent pharmaceutical packaging is sealed by the Controlled Delamination Material (CDM) and controlled by wireless communication. CDM is a thin layer of epoxy adhesive sandwiched between two pieces of metal substrate used to seal packages. RFID supports the application of providing the necessary medication at proper time and eliminates the non-compliance problem.

1.3 Intelligent Medicine Box
The iMedBox serves as a gateway for gathering the patients physiological information and delivers variety of medical services. The iMedBox is integrated with iMedPack by means of an RFID link. The medicine box can gather, record and display all the collected informations from the biopatch [1] and tracks the medicine utilities by automatically reading the RFID tags associated with each medicine stored in the medicine pack. The patient is automatically reminded to take the medicine on time by flashing on the screen.

1.4 Application Scenario
The iHome Health IoT system has been illustrated. The biopatch unit is a wearable biomedical sensor which detects and transmits the user’s biosignal to iMedBox at real time. The iMedPack is connected to iMedBox via RFID link to assist the patient with their prescribed medication. All the information collected will be interrupted, stored and displayed on iMedBox [3]. The patient cannot by hand open the iPackage which is sealed tightly by the CDM films unless an ‘OPEN’ command from the iMedBox according to the prescription The processed information can be forwarded to Health IoT network for clinical diagnosis. In case of an abnormality, the iMedBox triggers an alarm and automatically sends a text message to the doctor describing the situation. The doctor then prescribes on-spot medication or delivers the case to a nearby emergency center.

2 SYSTEM ARCHITECTURE AND SIMULATION
The block diagram of the system has been designed separately for patient set-up and doctor set-up. The communication between the patient set-up and doctor set-up is via a Bluetooth modem. The hardware component requirements for the proposed system includes a PIC16F877A microcontroller, heartrate sensor, temperature sensor, alert buzzer, RFID reader, max232, LCD display and Bluetooth modem.

2.1 Block diagram of patient set-up
The block diagram for the patient set-up consists of the heartrate sensor, temperature sensor, RFID reader, RFID tag, LCD display, alert buzzer and a Bluetooth modem. The block diagram of the patient set-up is shown in below in figure 1.

2.2 Block diagram of doctor set-up
The doctor set up consists of the doctor’s mobile and for the doctor set-up is shown in below in figure 2.

2.3 Block diagram Description
The biosignals (i.e., heart rate and body temperature) from the patient’s body are continuously analysed at real time using a heart rate sensor and temperature sensor respectively. The sensor outputs are given as input to the PIC 16F877A microcontroller and
the signals will be displayed on an LCD display at the patient side. The iMedPack is connected with the iMedBox via a RFID link to assist the users with their prescribed medication. In case of abnormality, the information will be displayed on the LCD display in the iMedBox and thus an alert buzzer will alarm at the patient and doctor side simultaneously. The Bluetooth modem helps in the communication between the patient set-up and doctor set-up. The doctor will immediately send emergency services and required medication for the patient at the earliest in case of emergencies.

3 RESULTS AND DISCUSSIONS

The simulation codings for the proposed system is programmed using MP LAB IDE and the simulation output is implemented in Proteus ISIS software. Here we have three PIC micro controllers.

- PIC1 connected to the bio-patch signal acquisition unit attached to the patient body for continuously analysing the body signals (here heart rate and body temperature) at real time which will be displayed on LCD1.
- PIC2 connected to the medicine box setup has an LCD2 which displays the condition of the patient whether the heart rate is normal or abnormal and also whether the body temperature is at either cold, good or fever state.
- PIC3 is connected at the doctor setup which receives informations of the current state of the patient from the medicine box and the LCD3 here displays once the medicines are emptied from the medicine box and alerts for the box to be refilled for the timely delivery of medication to the patient.

3.1 Body Temperature

The patient’s body temperature is measured continuously and displays three different outputs on LCD2.

- Cold (x<500)
- Good (x>500)
- Fever (x>800)

The output of body temperature is shown in fig 3

3.2 Heart Rate

The patient’s heart rate is measured continuously and displays two different outputs on LCD2.

- HB Normal
- HB Abnormal

The output of heart rate is shown in fig 4

3.3 Medication Management

The medicine box consists of eight boxes of prescribed medicines for the timely delivery of medication to the patient. Once the boxes are emptied after medicine consumption by the patient, the LCD3 at the doctor side indicates ‘MED LOW’ and correspondingly an alarm will be alerted at the medicine box to refill the boxes with the medicines. The output of heart rate is shown in fig 5

4 CONCLUSION

A preventive medication management and pervasive solution addressing the medication non-compliance problem has been proposed. The proposed iHome Health IoT system expands the scope and coverage of traditional health care information system extending
from a confined hospital environment and emergency centre to user’s home, body and medicine. The biopatch provides unobtrusive and continuous monitoring of user’s vital signs. The iMedBox serves as a home health care solution providing IoT network connectivity and strong interoperability. According to the online prescription by the doctor, a promising solution for the medication non-compliance problem is offered by the iMedPack by automatically reminding the user and dispersing required medicine on time. This newly emerging e-health monitoring system provides for personalized medication management, real time monitoring and acquisition of vital signs, seamless health care in comfortable home environment and also reduces the total expenditure on medical health care and treatment.

As a part of future work, the proposed system is to be implemented in hardware module. The RFID tag and CDM film can be integrated on to one flexible substrate. The iMedBox’s GUI can be enriched with more user friendly functions. By laminating a thin plastic insulation material over the patch which protect the conductive traces, can enhance the biopatch’s electrical and mechanical reliability.

REFERENCES


Dr. K. Sekar, received the B.E., degree in Electrical and Electronics Engineering from Bharathiyar university, Coimbatore,Tamilnadu,India and the M.E., degree in Power Electronics and Industrial Drives from Sathiyabama Institute of Science and Technology, Chennai, Tamilnadu, India. He is now Assistant professor in Electrical and Electronics Engineering, Hindusthan College of Engineering and Technology, Coimbatore, Tamil Nadu India. His areas of specializations are Power converters, Soft computing techniques, He has published 15 papers in National / International Journals and 10 papers in National / International Conferences to his credit.

Shiny Prakash SJ ,obtained her B.E. in Electronics and Communication Engineering from Cochin University, Kerala, (2013), and pursuing now M.E. in Applied Electronics (Anna university of Chennai). She is currently doing her project work on Biomedical Engineering.