Internet of things (IoT) based smart health care system

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***Abstract*—A BSN (Body Sensor Network) is a network designed to operate autonomously to connect the various medical sensors and implants located inside and/or outside of the human body; which offers flexible operation and cost saving options to both healthcare professionals and patients. This work illustrates the design and implementation of a smart health monitoring system. Here, a patient can be monitored using a collection of lightweight wearable sensor nodes for real time sensing and analysis of various vital parameters of patients. The devices seamlessly gather and share the information with each other and also store the information, making it possible to collect record and analyze data. Therefore, patients will have high quality services because the system supports medical staff by providing the real-time data gathering, by eliminating the manual data collection and by enabling the monitoring of huge numbers of patients.**

Keywords— Body Sensor Network (BSN), Arduino Fio, Wireless Communication, Pulse rate, Temperature, Blood Pressure, LabVIEW, Real-Time Patient Monitoring system.

I. INTRODUCTION

A BSN (Body Sensor Network) is a special purpose network designed to operate autonomously to connect to various medical sensors and implants located inside and outside of the human body. Introducing it in medical monitoring will offer flexibility of operation and cost saving options to both healthcare professionals and patients. They reduce user discomfort and enhance mobility. Applications in this category include monitoring of the human physiological data, tracking and monitoring of the patients inside a hospital, drug administration in hospitals etc [1]. Vitals signs are used to measure body's basic functions which can be helpful for monitoring general health of a person.

The main vision of the healthcare industry is to provide better healthcare to all the people anywhere and at any time in the world. This should be done in a more patient friendly and economic manner. Therefore for increasing the patient care efficiency, there is a need to improve the patient monitoring devices. The medical world today faces two problems in patient monitoring; firstly, the need of healthcare providers and care takers to be present at the bedside of the patient and second is that the patient is restricted to bed and is wired to large machines.

In order to achieve flexible and friendly patient care, the above mentioned problems should be solved and as the bioinstrumentation and telecommunications technologies are advancing, it has become more feasible to design a home based vital sign monitoring system to gather, display, record and transmit the physiological data from a human body to any location The rest of the paper [2].

II. RELATED WORKS

The work in [2] focused on developing tele-health monitoring system. This work presented a novel framework to provide healthcare to people anytime and anywhere in the world. The physiological parameters such as temperature pulse rate and ECG are obtained, processed using ARM7 LPC 2138 processor and displayed in a MATLAB graphical user interface. If any of the vital parameter goes out of normal range then an alert SMS will be sent to Doctor Mobile. The need of special software on the PC makes the work [2] little bit disadvantageous.

A novel patient tracking and monitoring system [3] explains a system that integrates vital sign sensors, location sensors, ad-hoc networking, electronic patient records, and web portal technology to allow the remote monitoring of patient status. This system shall provide communication between providers at the disaster scene, doctors' at local hospitals, and specialists available for consultation from distant facilities. This system is most useful in disaster management, but triage tagging would take time in a mass casualty disaster.

The paper is organized as follows. Section III deals with the Proposed Solution, section IV describes the details of the Materials and Methods used, section V explains the Working Principle, section VI explains about the Experimentation and results, section VII concludes the paper and gives the details about the Future work.

III. PROPOSED SOLUTION

Providing the healthcare services is very important for people especially who have chronic diseases. These people need continuous healthcare which cannot be provided outside the hospital.

There are many reasons which motivate to carry out the work: (1) making the healthcare more accessible for all the people who do not have access to healthcare providers and for people who do not have access to public transportation in order to go to hospitals; (2) giving medical staff more time to attend the patients who need more care; (3) preventing the

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delays in arrival of the patients' medical information to the healthcare providers, particularly in any accident or emergency situations; and (4) reducing manual data entry for patients' data which allows medical staff to monitor their patients efficiently.

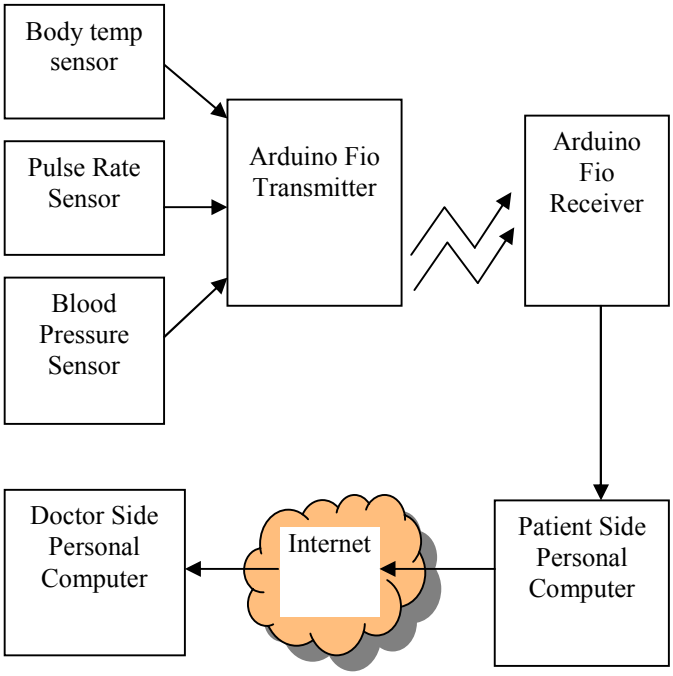

Fig.1. System representation

Fig.1 shows the proposed system representation where the different sensors are connected to the Arduino Fio transmitter board. The xbee module is connected to the board. The sensed values are wirelessly transmitted to the arduino receiver which is connected to the patient side computer and the values are read in labVIEW which is connected to the Internet. An URL is generated by labVIEW which can be accessed from any computer.

IV. Materials and Methods

This section discusses the basics of Arduino board, different sensors used and LabVIEW software.

A. Arduino Fio

Arduino Fio Based Zigbee Development Platform is an 8 bit development platform and provides means for the code development. It is based on ATmega328P AVR microcontroller and provides understanding of all the fundamentals of 8 bit microcontrollers. The Arduino Fio is intended for wireless applications [18].

The user can upload sketches (program) with a USB cable, or by using a modified USB-to-Xbee adaptor such as Arduino Fio Transmitter (Base); the user can upload the program through wireless using Xbee S1. Using the platform a range of projects in various domains like wireless communications, robotics, consumer electronics etc. can be designed.

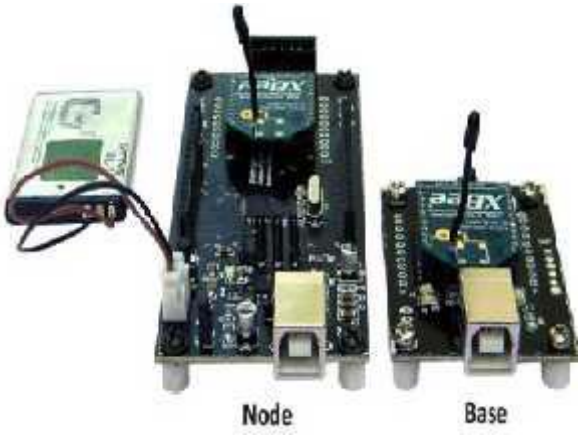

Fig. 2. Arduino Fio Node and Base

B. Temperature Measurement

The temperature sensing is done by using an IC LM35. The LM35 is a precision integrated-circuit temperature sensor, where its output voltage is linearly proportional to Celsius or Centigrade temperature [19].

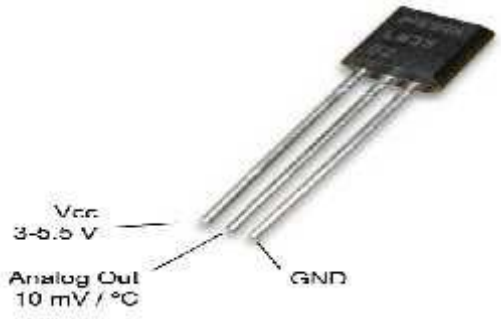

Fig.3. Temperature Sensor LM35

C. Pulse Rate Measurement

IR sensor pair basically consist an IR LED and a photodiode**,** this pair is generally called Photo Coupler. IR sensor works on the principal in which IR LED emits IR radiation and Photodiode sense that IR radiation. Photodiode resistance will change according to the amount of IR radiation falling on it and hence the voltage drop across it also changes and by using the voltage comparator (LM358) we can sense the voltage change and generate the output.

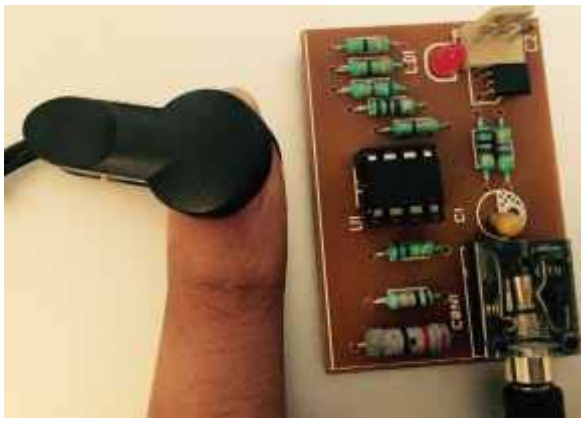

Fig. 4. Pulse Rate Sensor

D. Blood Pressure Measurement

Blood pressure is the pressure of the blood in the arteries as it is pumped throughout the body by the heart. When the heart beats, it contracts and pushes blood through the arteries to the rest of the body. Arterial pressure is defined as the hydrostatic pressure exerted by the blood over the arteries as a result of the heart left ventricle contraction. This force creates pressure on the arteries. Blood pressure is recorded as two numbers, the systolic pressure (as the heart beats) over the diastolic pressure (as the heart relaxes between beats). The device which measures this is called Sphygmomanometer. Here we use a wrist blood pressure monitor as shown in Fig 5.

Fig. 5. Blood Pressure Sensor

E. LabVIEW

The LabVIEW software is used as the integrating platform for acquiring, processing and transmitting the physiological data; it is an excellent graphical programming environment to develop sophisticated measurement, test and control systems using the graphical icons and wires that resemble a flowchart. The software also includes number of advanced mathematics blocks for different functions such as integration, filters and other specialized capabilities. The LabVIEWs' Professional Development System allows to create the stand-alone executables and the resultant executable can be distributed unlimited number of times. The run-time engine and the libraries can also be provided freely along with the executable.

F. Real-Time Monitoring using LabVIEW

The LabVIEW has been used to build computer graphics interface (CGI) programs and URLs, to send and receive the data using the Telnet protocol, to store and retrieve the files from FTP servers and to publish the VIs on the Web browser.

LabVIEW's built-in web server is used to publish front panels to the Web. LabVIEW makes publishing of VIs to the Web easy with the built-in LabVIEW web server. With the LabVIEW web server, the web pages are created dynamically with images of a VI's front panel, without the need for any special coding in the block diagram; all the details are handled by LabVIEW itself. The VI that is to be displayed in a web browser must already be loaded into the memory (in LabVIEW) to be served by LabVIEW web server [7].

The LabVIEW web server can publish the VI to the Web in one of the three ways (1) Snapshot, static ("snapshot") image of a VI's front panel; (2) Monitor, an image of a VI's front panel that can be configured to auto-refresh every N seconds and (3) Embedded, a controllable version of the VI in front panel. This option uses a browser plug-in to display the VI in real time and allows users to control the VI.

Using write-to-measurement file present in LabVIEW the clinical information like Temperature, Pulse rate and Blood Pressure is stored along with the date and time the values are generated in an excel sheet.

V. WORKING PRINCIPLE

This section describes about the algorithm and the working principle of the proposed system.

A. Algorithm

- Connect the sensors to Arduino Fio transmitter board as well as to the patient.
- The values are acquired and are stored in the form of an array.
- Connect the Arduino Fio receiver to PC using USB.
- Send wirelessly the acquired parameters to the receiver.
- Received values are read by VISA (Virtual Instrumentation Software Architecture) in LabVIEW enabled PC.
- The sensor values are restored by typecasting from ASCII to normal.
- The values are compared with threshold values to indicate any abnormal condition.
- These vital parameters are also displayed on the front panel.
- The values are also stored in a file for further assistance in the treatment of the patient.
- Using web publishing tools in LabVIEW the front panel can be seen remotely.

B. Working

The different sensors are placed at the respective locations on the human body and are connected to the Arduino board. For the temperature sensor output from LM35 is converted to digital form with the help of ADC pins of Arduino board. For the pulse rate sensor when the heart pumps blood through the blood vessels, the finger becomes slightly opaque and so less light reaches the detector. With each heart beat the detector signal varies and this variation is converted into electrical pulse. The pulse is also indicated by an LED which blinks on each heartbeat.

Typical Blood Pressure monitors are big, bulky, and nearly impossible to use without assistance. We just need to

use the Velcro straps to easily secure Monitor to the wrist and push the blue button. In less than one minute we'll have systolic blood pressure and diastolic blood pressure. The display is large and easy to read. The processing of ECG signal (Fig 7) is also done by using the biomedical tool kit present in LabView.

Fig. 6. Hardware setup

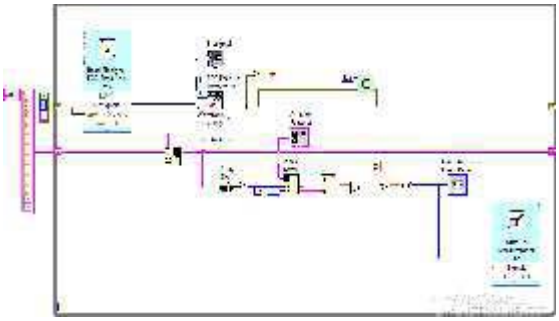

Fig 7. ECG Processing

These values are now wirelessly transmitted and seen on the Arduino serial monitor. The output at the receiver side is shown in fig 8.

Fig. 8. Arduino Output at the Receiver

VI. EXPERIMENTATION AND RESULTS

This system can be used to transmit the patient vital parameter information in real-time to remote location and can be seen by the care taker. The sensors are connected to the Arduino Fio transmitter board. The sensed values are transmitted wirelessly to the Arduino Fio receiver which is connected to the central station personal computer.

The fig. 9 shows the block diagram of the VI in which the data from the Arduino Fio is read through the USB and then received by VISA in LabVIEW.

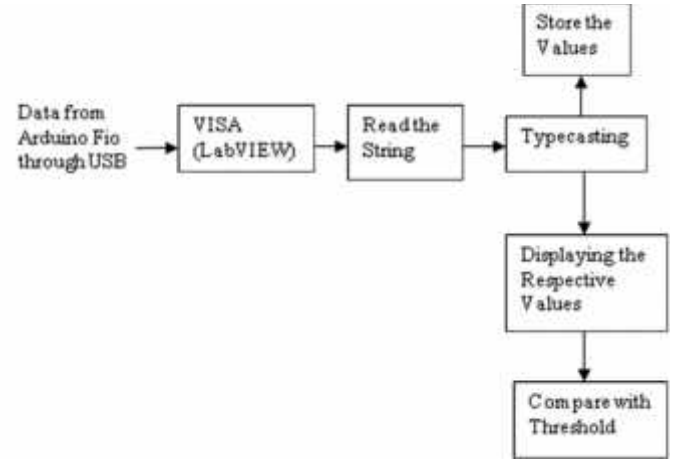

Fig. 9.Block diagram of the VI

This data is now read in the string format and is type casted accordingly. The typecasting is done to convert the values from ASCII to normal values. These values are now stored in the excel sheet by using the write-to-measurement file in LabVIEW as well as displayed on the front panel. The obtained values are compared with the threshold values to check for any abnormal condition.If any such condition prevails an alarm and an LED glows indicating it. The published web page is shown in fig 10.

Fig. 10. Remote Panel output

VII. CONCLUSION AND FUTURE WORK

In this paper, tele-monitoring application is presented which allows the doctor to view the patient's vital parameters remotely and dynamically in a Web page in real time and doesn't need to have any special requirement on the PC; all he needs is an Internet access. For the patient side, a home based LabVIEW application which is embedded in home PC is required.

In future this work can be extended by adding the ECG sensors to the existing set-up. This work is done based on single person's data collection and in future this can be extended to multiple people.

References

[1] Jamil Y Khan And Mehmet R Yuce "Wireless Body Area Network(wban) For Medical Applications".

[2] Suhas Kale and C. S. Khandelwal " Design and Implementation of Real Time Embedded Tele-Health Monitoring System" International Conference on Circuits, Power and Computing Technologies, 2013.

[3] Tia Gao, Dan Greenspan, Matt Welsh, Radford R. Juang, and Alex Alm, "Vital Signs Monitoring and Patient Tracking Over a Wireless Network" IEEE EMBS 2005.

[4] S. M. Riazul Islam, Daehan Kwak, Md. Humaun Kabir, mahmud Hossain, And Kyung-sup Kwak, "The Internet Of Things For Health Care: A Comprehensive Survey". IEEE Access, June 2015.

[5] Luca Catarinucci, Danilo de Donno, Luca Mainetti, Luca Palano, Luigi Patrono, Maria Laura Stefanizzi, and Luciano Tarricone. "An IoT-Aware Architecture for Smart Healthcare Systems". IEEE JOURNAL, Dec 2015.

[6] Aleksandar Milenkovic´ , Chris Otto, Emil Jovanov, "Wireless sensor networks for personal health monitoring: Issues and an implementation". Elsevier 2006.

[7] Bhavin Mehta, Divya Rengarajan, Ankit Prasad, "Real Time Patient Tele-monitoring System Using LabVIEW", International Journal of Scientific & Engineering Research, April 2012.

[8] Ashwini Singh, Ajeet Kumar, Pankaj Kumar, M.A Mujeeb. "Body Sensor Network: Monitoring And Analyzing Real Time Body Parameters In Medical Perspect". IJESE May 2013.

[9] Enrique Dorronzoro Zubiete, Luis Fernandez Luque Ana, Ver´onica Medina Rodr´ıguez, Isabel G´omez Gonz´alez . "Review Of Wireless Sensors Networks In Health Applications". IEEE Conference Sept 2011.

[10] Ning Xu "A Survey Of Sensor Network Applications". IEEE Communications Magazine 2002.

[11] Loren Schwiebert, Sandeep K. S. Gupta, Jennifer Weinmann "Research challenges in wireless networks of biomedical sensors". MobiCom '01 conference.

[12] Mohammad S. Jassas, Abdullah A. Qasem, Qusay H. Mahmoud "A Smart System Connecting e-Health Sensors and the Cloud". IEEE conference May 2015.

[13] Dr. Salah S. Al-Majeed, Dr. Intisar S. Al-Mejibli, Prof. Jalal Karam. "Home Telehealth by Internet of Things (IoT)". IEEE conference May 2015.

[14] Rolim, C.O. Koch,f.L. Westphall, C.B. Werner, J. Fracalossi, A. Salvador, G.S. "A Cloud Computing Solution For Patient's Data Collection In Health Care Institutions" IEEE Conference Feb 2010.

[15] Purnima, Neetu Rout, Rahul Tiwary, Renuka Bhandari "Zigbee And Gsm Based Patient Health Monitoring System" IJAREEE Jan 2014.

[16] Michael R. Neuman, "Measurement of vital signs: Temperature", IEEE Pulse Sept/Oct 2010.

[17] Jeffrey Travis and Jim Kring, "LabVIEW for Everyone", Prentice Hall publications, 2006.

[18] Dr. M. Armugam, " *Biomedical Instrumentation"*, Anuradha publications, 2002.

[19] https://www.arduino.cc/en/Main/ArduinoBoardFio.

[20] http://www.ti.com/product/LM35.