ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2016

A Low Power, Mixed Signal System for Wireless Transmission Of Body Temperature, Heart Beat and ECG

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ABSTRACT: This paper presents design methodology of wireless remote patient monitoring system. Human's electrocardiogram (ECG), body temperature and heart rate information are acquired from body of the patient and sent to a PC/laptop using IEEE 802.15.1 Bluetooth. The body parameters values are shown on NI LabVIEW in digits and in waveforms. If vital values of body parameters are detected, then the information is sent to the doctor section using GSM/GPRS wireless technology. In this way, remote patient monitoring is achieved in real time which further minimize the rush in the hospital and further reduces the patient expenditure also. The system designed not only monitored the patient from remote place but early treatment can also be given in case any abnormalities in the parameter values. Furthermore, the real time values displayed on the PC/ Laptop of patient can be continuously monitored by the doctor in his PC/ Laptop using Team viewer which allows connectivity in both sides. Thus, through this way the daily life of human can be made easier and more comfortable.

KEYWORDS: IEEE 802.15.1, GSM/GPRS, LabVIEW, ECG, LUT.

I. INTRODUCTION

Wireless remote patient monitoring system is in demand now days. This project aims to design and test a method for monitoring the patient's data such as ECG, pulse rate & temperature wirelessly from a location to the remote site where this data could be investigated by the cardiologist.

Electronics has found tremendous applications in healthcare now days and has become a major solution for detection and diagnosis of many diseases. Healthcare professional using many electronics equipment's for patient's diagnosis. Due to a shortage of physicians we need to begin to look at ways of easing the workload on current health care professionals so that they can take on more patients. This need encouraged the electronics engineers to design and develop advance technology in biomedical field.

Human body generates certain physiological signals such as the electrical activity of the heart, temperature, the pulse rate concentration which can be measured and analysed for detection of diseases. With the prior knowledge a physician can provide an accurate diagnosis faster which reduces patient wait times and the work load on our healthcare professionals.

If a system is designed which can measure and transmit these body parameters to a remote consultant could save many of these patients. This could also help to reduce the trouble taken by many patients to travel vast distances to be seen by the cardiologists. The system design aims to provide solutions to the problems encountered in transmission of ECG and other body parameters from a location to a remote site where this data could be investigated by a cardiologist.

Patients heart beat measurement can be achieved either by the waveform of ECG or by detecting the flow of blood into the finger, this method is called as pulse method. The pulse method for heart beat detection is easy and convenient. The blood flows into the finger and the body parts during hearts systolic stroke via the radial artery on the arm. The photo detector can be used for sensing the blood flow into the finger. Small light source can be used on one

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side of the finger to count the heart beats, by observing the light intensity changes on the other side. Due to the blood flow light intensity changes which further changes the signal strength by changing the LDR's resistance.

Tape recording of ECG signal based heart disease diagnosis is used now days which can be studied and analysed using a microcomputer. This paper presents the design and implementation of a configurable, microcontroller-based portable system for diagnosis and controlling of heart rate, ECG and Temperature on real time. The Tape recording systems for recording ECG signals are large in size and prone to mechanical failure as well as it needs large batteries. In order to reduce the size, weight and power consumption of the system, a single chip Reduced Instruction Set Computer (RISC) architecture ARM 7 family LPC 2148 microcontroller is chosen. The heart beat sensor Model 1157 of SUNROM technology is used to provide pulse rate from body to the Analog to Digital converter circuit which is mounted on LPC 2148 microcontroller. LM35 Precision Centigrade Temperature Sensors is used to measure body as well as atmospheric temperature. 16*2 liquid crystal display is used to display the temperature in Fahrenheit, pulse rate in beats per minutes and ECG values.

The remote patient monitoring can be achieved by telemedicine and telemonitoring. A telemonitoring network devoted to medical teleservices, which mainly focuses on those people who live in rural and isolated area [1].
Through this system doctor can continuously get the update about patient health status. Physicians can also take the information about the disease from expert and provide the best health care available. Moreover, patients can achieve comfort and thus save time and money and hospital rush can also be reduces.

On the basis of a reliable transmission scheme, In this project the implementation of a Bluetooth device for monitoring, which transmits the values of body parameters i.e. temperature, pulse rate and ECG to the patients PC/ Laptop for monitoring and displayed the waveforms in LabVIEW in real time is achieved. This transmission scheme ensures the success full transmission of these parameters values. The experimental result shows that the designed system is fast and reliable.

In This Project the system designed provides solutions to problems that are occurring in transmission of patient monitoring data such as ECG, pulse rate & temperature from a location to the remote site where this data could be checked by the cardiologist.

Certain sensors are used to measure the body parameters and show them on PC screen.
The overall objective of this work is to design and implement a prototype patient monitoring system in which doctor can continuously monitor the patient body parameters wirelessly who is in remote place and not in reach of hospital and inform doctor regarding fatal parameters values by sending SMS, so that doctor can call patient to hospital or reach to patients place and provide him rapid treatment.

Electrocardiogram (ECG) signals show the electrical activity of the heart. The patient can be continuously monitored from his residence. Different electrodes and sensors are available which can be placed on desired locations of the patient's body to record the raw data, filtered it and to display graphically using LabVIEW software. The recorded data is then transmitted to the doctor using wireless transmission to examine the ECG signals and guides the patient regarding any emergency medical aid required and also monitors and keeps a track of the entire patient's data periodically. The wireless transmission the body parameters are achieved using Bluetooth technique which is an efficient way of transferring data. Using Bluetooth and internet in the PC/Laptop the data from each sensor is received and transmitted to the doctor using Team Viewer.

II. LITERATURE SURVEY

Different ECG Monitoring system architecture is discussed in this section:
The several methods of design of wireless ECG systems are available**:** The system discussed in [2] consists of three subsystems which include patient subsystem, web server and database subsystem and android unit subsystem. Patient unit subsystem includes electrodes for acquisition of heart's electrical activity, it also includes instrumentation amplifier for signal amplification and conditioning and patients PC. The suitable timing can be set to send the data to patients PC.
Web Server and Database subsystem is used for storage of ECG signal data publish the result for any abnormality and it can be accessed by authorized person. This system includes following stages,

- Database Implementation
- Abnormalities Detections

The android based applications are used by the doctor to accessing the patient details using mobile. Here two applications are developed one for doctor called ECG Note and another for patient called My Note.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

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The system discussed in [3] is implemented by using a specially designed ECG amplifier and a low power microcontroller board of Texas instrument (eZ430-RF2500). The designed module of ECG is connected wirelessly to a personal server for receiving the information from ECG Module.

The design of wearable wireless ECG monitoring system is proposed in [4], [5] where motion artefact is reduced using adaptive filter with LMS algorithm. Also LUT is used to replace MAC unit in the LMS core. This LUT is optimized by using APC-OMS technique. The advantage of optimized LMS algorithm is that it consumes less power and small in size than the existing LMS algorithm. A novel VLSI architecture is developed and implemented for LMS algorithm for wearable ECG ASIC for size and power reduction.

The real time portable ECG monitoring system is implemented in [6] in which the acquired ECG data from the sensor are wirelessly transmitted using Zigbee-802.15.4 wireless module. The same module is used at the receiver to receive wireless signal transmitted by the transmitter and then send to the com port of PC for further processing of ECG signal.

There are techniques discussed in [7], [8], [9], and [10] that are based on encryption and cryptographic algorithms. Such techniques can be used to secure data during the communication and storage. As a result, the final data will be stored in encrypted format.

III. SYSTEM DESIGN CONCEPT

The block diagram of the designed system is shown in fig. 1. The ARM 7 family LPC 2148 processor board is used as a heart of the project. The body temperature of patient's body is taken through LM 35 precision centigrade temperature sensor and it is provided to the processor for further processing and converting into the Fahrenheit.

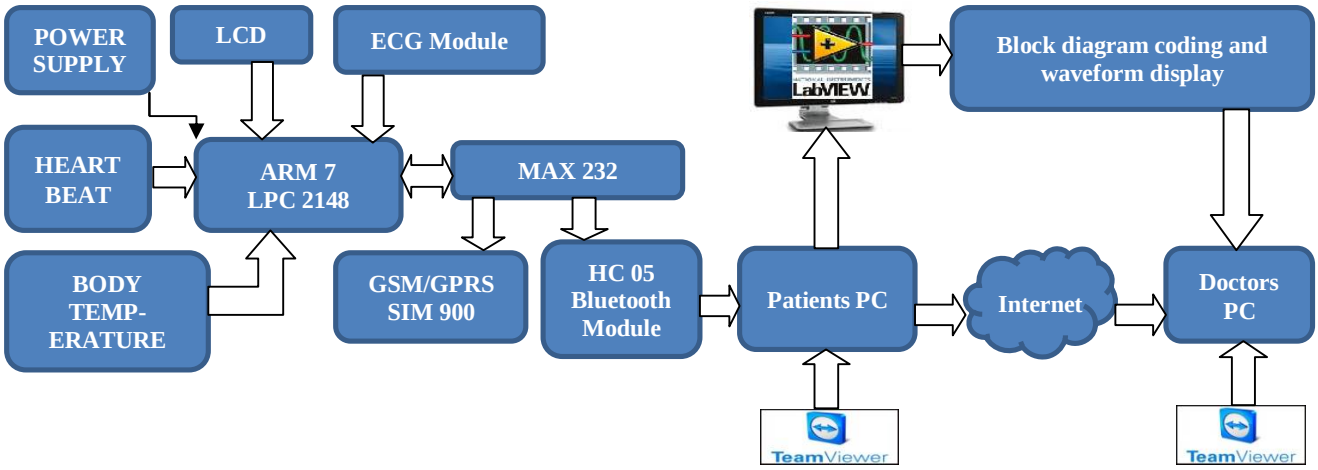

Fig. 1. Block diagram of designed system

The system is supplied by 9V power supply circuit which is obtaining through transformer of 230V/ 9V. The DC supply through transformer is provided to the ARM 7 board, Bluetooth module and ECG circuit. The GSM/ GPRS SIM 900 are powered by using adaptor of 5V.

The IR based heart beat sensor is used to find the pulse rate of the patient by placing the finger between the LED and Photo diode which detects the flow of blood through veins and detect it. The ECG is electrical potential generated by heart muscles which is extracted by ECG electrodes and provided to the ECG amplifier which amplifies the tiny potential changes and provided it to the ARM 7 board to convert it into digital signal for processing.

The Bluetooth module is connected to the ARM 7 board through UART 0. The processed ECG, Temperature and Heart beats are provided to the Bluetooth module which further transmits it wirelessly to the PC/Laptop on which real time values of body parameters and their graphs are displayed using NI LabVIEW 2008 Software.

The system is divided into two parts i.e. Patient Section and Doctor Section. The hardware system is used in patient section and real time data display on PC/ Laptop using LabVIEW is also the part of patient section. The

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ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

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wireless transmission of the data is achieved by using Team viewer software which allows connectivity in both sides in this way doctor can access the PC/Laptop of patient using Team viewer. This requires internet connection in both sides.

Keil µvision4 software is used to write the coding in embedded C and it is dumped into the system using Flash Magic.

If the values of the body parameters and pulse rate exceed the normal range then message is send to the doctor section and accordingly immediate treatment can be provided to the patient.

IV. DESIGN OF ECG AMPLIFIER

The Electrocardiogram (ECG) is the tiny potential voltage changes in the heart muscles during arterial depolarization and ventricular repolarisation. But the voltage generated in the heart muscles is very small in amplitude hence we need to use an amplifier circuit which can responds to the extremely low input voltage and provide large amplification. It consists of LM 324 quad Op-Amp which is used to design a low-noise and low-power instrumentation amplifier (IA). The IA designed is having high CMRR and a chopper stabilized current balancing IA [11] designed to operate over 1.2 V supply. The important advantage of this type of IAs is that the common-mode rejection ratio (CMRR) does not depend upon passive devices matching [12], [13] and it extensively provide a CMRR in excess of 100 dB. The AgCl electrodes are used which are placed on the human body on right arm, left arm and right leg. The electrodes convert tiny electrical potential changes into the voltage which is in mill volt and then amplified using IA. The gain of the IA is adjusted using the values of resistors.

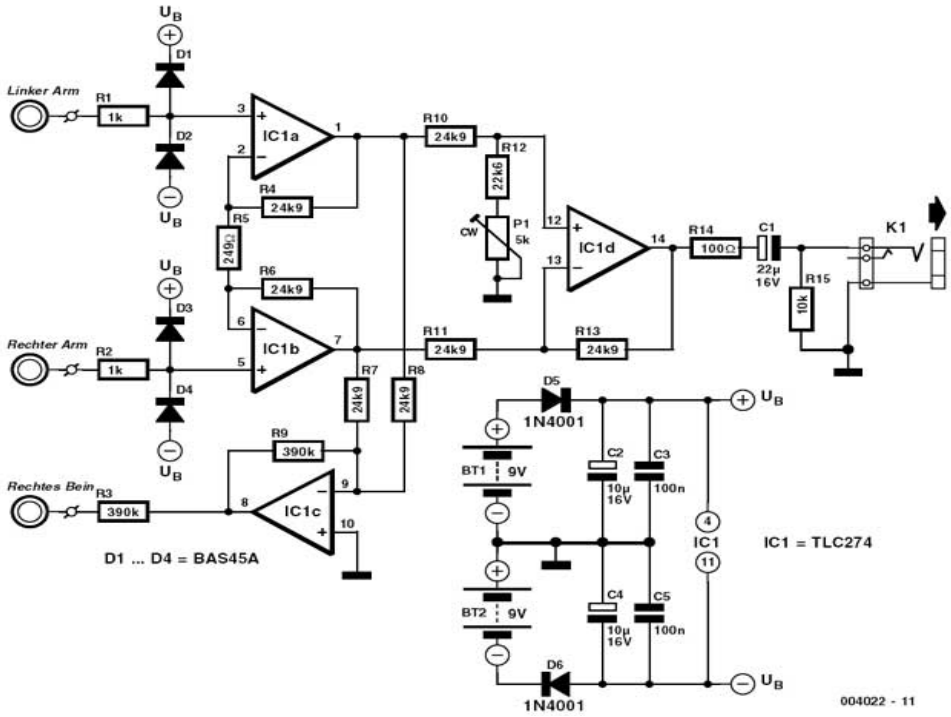

Fig. 2. Circuit Diagram for ECG Amplifier

The designed module provides high throughput and pre-processing circuit gives ECG input stream in real-time. Figure 2 shows ECG processing system extracting the signal from electrodes placed on human body to analog front end and processed with ARM 7 LPC 2148. We refer Elektor, edition 7-8/2000 and got simple ECG amplifier circuit that we selected for designing the ECG amplifier as shown in figure 2.

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V. SIMULATION USING LabVIEW

National Instruments NI LabVIEW is used in this project for simulation. The main objective of the ECG simulator is to produce the typical ECG waveforms of different leads and other body parameter values. LabVIEW based simulator is able to produce these waveforms. The three electrodes are connected to the left arm, right arm and right leg. The acquired ECG is then amplified by using ECG amplifier shown in figure 2.

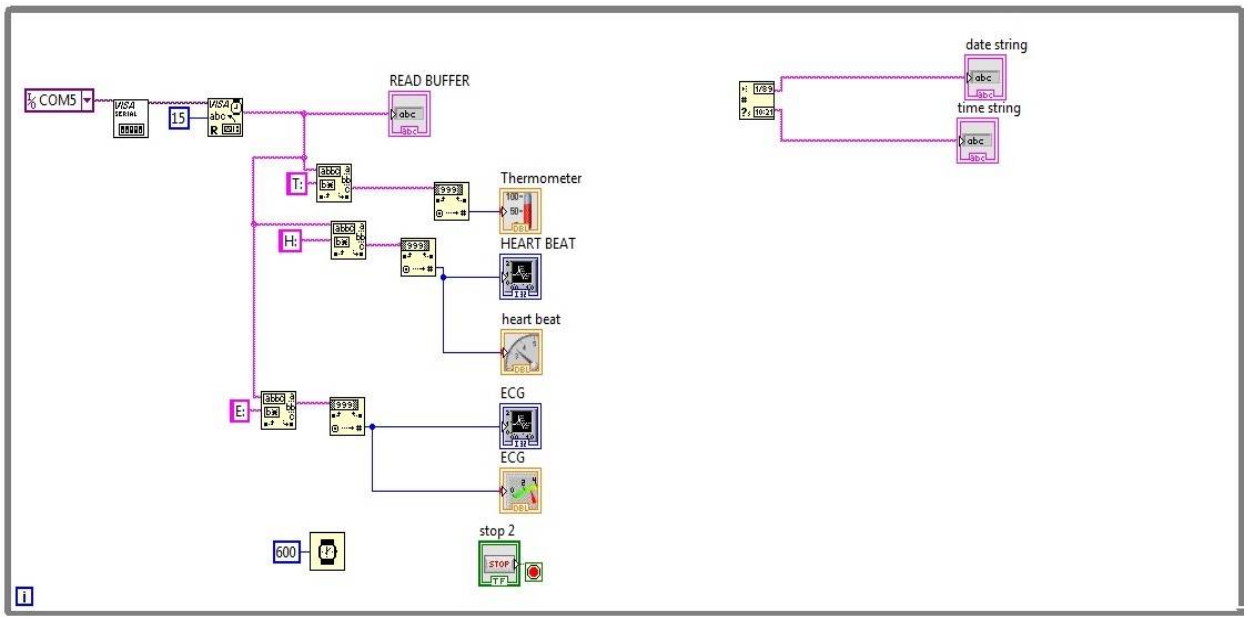

Fig. 3. ECG, Temp. & Heart beat Simulation block diagram in LabVIEW

The ECG, Body Temperature and Heartbeat of patient are acquired through sensors, processed it in LPC 2148 and transferred wirelessly to PC/ Laptop using HC05 Bluetooth module. The received parameter values are provided to the VISA serial port through com port and then converted into proper format for display as a decimal number values as well as in the graphical form. The LabVIEW coding block diagram is shown in figure 3.

A. TYPICAL ECG WAVEFORM

A typical scalar electrocardiographic lead is shown in Fig. 4, the different points P, Q, R, S, and T waves in ECG graph are shown, the time intervals such as the P-R, S-T, and Q-T intervals are shown.

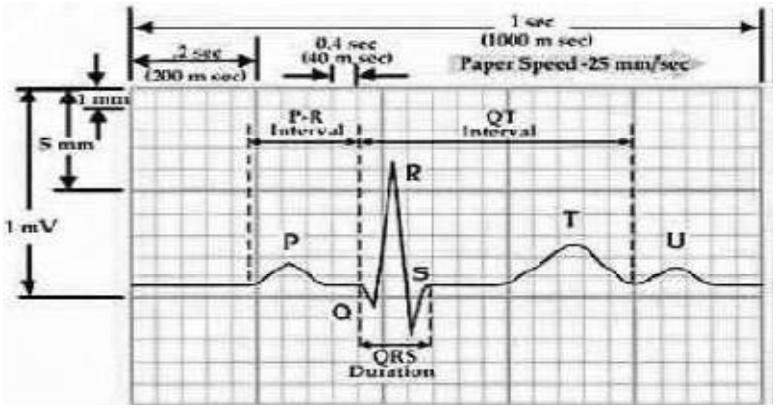

Fig. 4. Typical ECG Signal

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B. ECG R-PEAKS DETECTION

The R-peaks detection is the basic task of electrocardiogram (ECG) processing. Several problems may occur during ECG processing such as: irregularity in distance between the peaks, irregular peak form, generation of low-frequency component in ECG due to patient breathing etc. To overcome those problems the noise reduction and signal filtering and its amplification achieved in stages.

V. WIRELESS TRANSMISSION

Various wireless network technologies have been used in health monitoring system; however, in this project the HC 05 Bluetooth module is used for wireless transmission of the body parameter values to Laptop/ PC of patient.

With the help of internet in both the side Laptop/ PC of patient section and doctor section Team viewer is used for transmission of the patient's body parameter status to the doctor, as Team viewer allows the connectivity in both the side.

VII. DESIGNED SYSTEM WITH RESULTS

The designed system is shown in figure 5. The results in the form of values and waveforms are displayed in NI LabVIEW 2008 simulating software. The results meet the standard values. The screenshot of the real time waveforms are shown below in figure 6. The voltage of QRS is obtained up to 0.5 to 1 mV from the body of the patient and it is then amplified by using Instrumentation Amplifier which is designed by using LM 324 quad Op-Amp whose open loop gain is 100V/mV. The closed loop configuration is used in a instrumentation amplifier whose gain is decided by the values of resistors. Here the gain so selected to get the ECG output voltage to 1V. One ECG cycle is generated according to the beat rates i.e. we measured one ECG cycle in time duration of 0.8 seconds for a 75 bpm heart beat reading. Heart beats of person in normal condition are measured which ranges from 72 to 77 beats per minutes. Heart beats are measured immediately after heavy exercise i.e. by running and push-ups which exceeded 100 bpm and SMS was sent to the mobile.

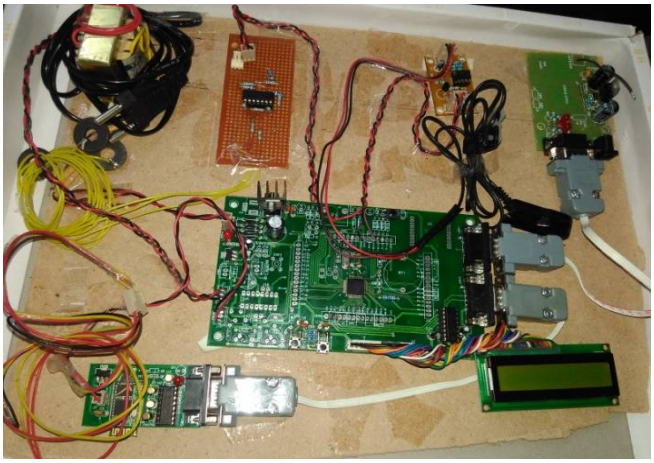

Fig. 5. Designed system photograph

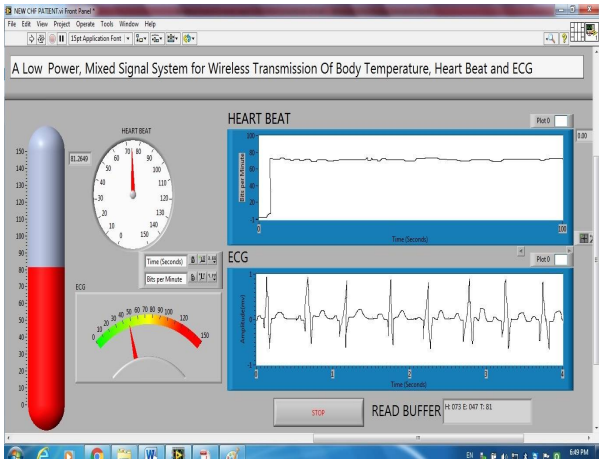

Fig. 6. LabVIEW Simulator graph and Waveforms

The temperature of the atmosphere in normal condition is measured by LM 35 the precision centigrade temperature sensor which was varying around 27°C with a tolerance of 1 to 1.5° C. The temperature increases as the LM 35 subjected to the high temperature and message is sent to the mobile when temperature exceeds 100°F. Here temperature is rated in Fahrenheit. The degree to Fahrenheit conversion can be achieved by following formula.

$$T_{(°F)} = T_{(°C)} \times 9/5 + 32.$$

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VI. CONCLUSION AND FUTURE WORK

The system discussed in this paper can be used for real time wireless remote patient monitoring. For any emergency situation i.e. when body parameters exceeds normal values then SMS is sent to the doctor using SIM 900 GSM/ GPRS module which further helps to alert the doctor to take immediate action to diagnose the patient. With the implementation of this system will reduce the hospital rush and patient expenditure as well. The system used hardware modules IR Heart beat sensor, LM 35 temperature sensor and ECG Amplifier shown in figure 2. The LPC 2148 is the advance RISC machine used for signal processing and providing the output in real time. Use of Bluetooth module allows ease of communication between hardware system and PC/Laptop of patient section. The system also require less power for operation as it is supplied through adaptor of 5V and Power supply of 230 V/ 9V.

In software part the embedded C is used for program which is written in Keil uVision4 and dumped into the system using Flash Magic. LabVIEW is used for simulation and waveform display. The use of Team viewer allows the connectivity between patient and doctor PC which is then used for continuous monitoring of patient from his hometown by the doctor at hospital. The overall designed system is configurable, low power and cost efficient.

Further advancement can be done in the system in which various algorithms can be used to make it more configurable and wearable system, so that patient can be monitored while doing his regular activities and motion artefacts can be removed considerably by using Adaptive filters APC-OMS, LMS algorithm and advance SoC.

REFERENCES

1. Anon. *Cost of Health Care to reach $172 billion: report.* CanWest Media Works Publications Inc. Ottawa Citizen, November 14, 2008. http://www.canada.com/ottawacitizen/news/story.html?id=c18006b1-1406-4bbe-9dbfc7edaf652d42
2. Alauddin Al-Omary, Wael El-Medany, Riyad Al-Hakim, "Heart Disease Monitoring System Using Web and Smartphone", IJAREEIE,Vol. 3, Issue 4, April 2014
3. Cristian Rotariu, Hariton Costin, Dragoş Arotăriţei And Bogdan Dionisie, "A Wireless ECG Module For Patient Monitoring Network", Buletinul Institutului Politehnic Din Iaşi Publicat De UniversitateaTehnică „Gheorghe Asachi" Din Iaşi TomulLiv (Lviii), Fasc. 1, 2008 SecţiaAutomaticăŞiCalculatoare
4. S. AnusuyaDhandapani, Samiappan and P.R. Buvaneswari,"Design and Implementation of Motion Artifact Reduction Asic for Wearable Ecg Recording",American-Eurasian Journal of Scientific Research 10 (3): 154-159, 2015 ISSN 1818-6785 © IDOSI Publications, 2015 DOI: 10.5829/idosi.aejsr.2015.10.3.22277
5. R. Ezhilan and A. Balamurugan," Wearable Electrocardiogram recording using Application-specific integrated Circuit (ASIC)", Advances in Natural and Applied Sciences, 9(8) July 2015, Pages: 70-76
6. PrakashVidwan, PradipPanchal, Sachin Sharma," REAL TIME PORTABLE WIRELESS ECG MONITORING SYSTEM", Asian Journal Of Computer Science And Information Technology 2: 6 (2012) 158 – 161.
7. W. Lee and C. Lee, "A cryptographic key management solution for hipaa privacy/security regulations," IEEE Transactions on Information Technology in Biomedicine,, vol. 12, no. 1, pp. 34–41, 2008.
8. I. Maglogiannis, L. Kazatzopoulos, K. Delakouridis, and S. Hadjiefthymiades, "Enabling location privacy and medical data encryption in patient telemonitoring systems," IEEE Transactions on Information Technology in Biomedicine,, vol. 13, no. 6, pp. 946–954, 2009.
9. F. Hu, M. Jiang, M. Wagner, and D. Dong, "Privacy-preserving telecardiology sensor networks: toward a low-cost portable wireless hardware/ software co-design," IEEE Transactions on Information Technology in Biomedicine,, vol. 11, no. 6, pp. 619–627, 2007.
10. H. Wang, D. Peng, W. Wang, H. Sharif, H. Chen, and A. Khoynezhad, "Resource-aware secure Ecg healthcare monitoring through body sensor networks," Wireless Communications, IEEE, vol. 17, no. 1, pp. 12–19, 2010.
11. R. F. Yazicioglu*et al.*, "A 30- W analog signal processor ASIC for biomedical signal monitoring.," *IEEE J. Solid-State Circuits*, vol. 46, no. 1, pp. 209–223, Jan. 2011.
12. X. Zou*et al.*, "A 1-V 450-nW fully integrated programmable biomedical sensor interface chip," *IEEE J. Solid-State Circuits*, vol. 44, no. 4, pp. 1067–1077, Apr. 2009.
13. N. Verma*et al.*, "A micro-power EEG acquisition SoC with integrated feature extraction processor for a chronic seizure detection system," *IEEE J. Solid-State Circuits*, vol. 45, no. 4, pp. 804–816, Apr. 2010.

BIOGRAPHY

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