Monitoring of ECG using Zigbee and Wamp Server

Ramu R, College of Engineering Trivandrum 1; Sukesh Kumar A ,Rajiv Gandhi Institute of Development Studies 2

Abstract

Abstract- According to the Prospective Urban Rural Epidemiologic (PURE)study,more than 80 per cent of deaths due to cardiovascular diseases are estimated to occur in middle-income and low-income countries like India.Many of them die due to lack of awareness and access to proper treatment.Early detection of cardiovascular disease symptoms help to give treatment as early as possible .This can be made possible for patients living in remote environment using telemedicine by continuously monitoring the cardiac patients. A wireless electrocardiograph monitoring system is implemented with Zigbee module and Wamp server for remote monitoring of cardiac patient. The ECG acquisition module is interfaced with Zigbee Transmitter module. The transmitted signals are then received by Zigbee Receiver module which is connected to a laptop.This laptop is configured as local server and the serial ECG data from the receiver are fed to the database of the local server.ECG signals are plotted in the browser of the laptop configured as server.Finally ECG signals are transmitted and plotted in a remote laptop using internet.By this method a doctor can view the ECG of his patient in laptop or mobile phone using internet connection.

Keywords- ECG, LabVIEW, Local Server, Telemedicine, Zigbee.

Introduction

The rate of cardiac diseases in India has increased especially among young men, and about 35 percent of deaths in India are due to cardiovascular diseases. Majority of them die due to heart attack because they cannot reach hospital within an hour. This is mainly due to the improper food habits, lack of physical activity, stress, smoking and alcohol consumption .This will also affect the economic growth of country due to increased healthcare expenditure. Prevalence of cardiovascular diseases in India is higher than other countries of the same region [1]. Telemedicine is a remote health care service which will bring a remote patient and doctor in close contact with the help of communication technology. There are many applications for telemedicine and it offers great opportunity as an alternative way of delivering health service to rural areas [2].Telemedicine has a great impact in the cardiac monitoring of patients in remote environment .One of the recent developments in telemedicine is the monitoring of patients with cardiac disorders within the home or rural hospitals .Early detection of heart disease sign has important significance for heart disease prevention and timely treatment. Wireless technologies are developing very fast and medical devices also use wireless connectivity to maintain a connection to monitoring systems. There are different wireless technologies that are used to transmit ECG signals

such as Bluetooth, Zigbee Wi-Fi and GSM. This work is an extension of the earlier works of the authors [3].

ECG monitoring system with Bluetooth low energy (BLE) technology reduces the power consumption of long term monitoring system. Bluetooth technology enables low power and short range wireless connection. A wireless ECG monitoring system with BLE transmit ECG signal via Bluetooth wireless link,process and display the ECG waveform in a smart phone[4].Wireless ECG transmission using Wi-Fi technology is developed which consist of a single chip ECG signal acquisition module on Concerto Microcontroller Unit, SimpleLink Wi-Fi module and a smart phone [5]. An internet based ECG telemonitoring in which communication between the patient and doctor is done through client-server architecture [6]. In this work ECG signal from the acquisition module is transmitted to the laptop using zigbee module. The ECG signals are plotted in the browser of the same laptop configured as server. These signals are then plotted in the web browser of the remote laptop using internet protocol address of the laptop configured as server.

System Description

The aim of the work is to design an inexpensive highly accurate ECG acquisition and wireless transmission system using zigbee and local server. The Figure.1 shows the main block diagram of the system
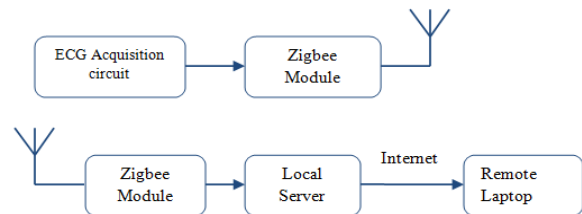

Figure.1. Block diagram of the system.

The ECG acquisition system consists of electrodes, instrumentation amplifier, filters and microcontroller. It captures the ECG signal from the surface of the body, then it amplifies the signal from millivolt range to volt range. Filters will remove undesired signal and pass only the ECG signal. The analog output from the filter is given to microcontroller for analog to digital conversion (ADC) and the serial data from the output of microcontroller is wirelessly transmitted using

50

Zigbee transmitter module. The Zigbee receiver module will receive the transmitted ECG data. The ECG acquisition system is designed first and the output is displayed in the laptop using LabVIEW software. Then the acquisition part is interfaced with the Zigbee module and transmitted the signal to Zigbee receiver module which is interfaced with the laptop. The transmitted ECG signals are plotted in the laptop using LabVIEW in real time.After configuring the same laptop as local server the ECG signals are then stored in the data base of the server.Wamp server is used as local server.The Signals are then plotted in the browser of the server.The ECG signals are finally plotted to another laptop using internet.

ECG Acquisition System

The signals acquired from the electrodes are amplified, filtered, digitized, and transmitted. The differential amplifier differentiates the signals coming from the two lead electrodes and amplifies it to fit in to the analog input range of an analog-to-digital converter (ADC). Unwanted frequency components are then removed using filters. The processed signal is then digitized with an ADC in Atmega microcontroller and sent to Laptop. Block diagram of ECG acquisition system is shown in Figure. 2
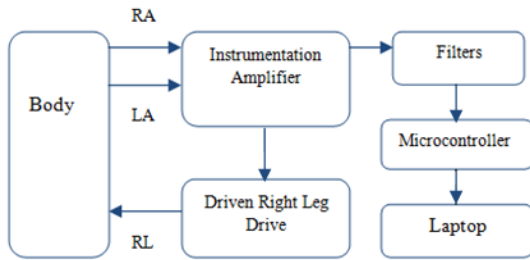

Figure. 2. Block diagram of ECG acquisition system

In this work 3-Lead ECG is used, for this 3 electrodes are used and are placed according to Einthoven's triangle. The most common and effective use of the third electrode is to connect it to a driven-right-leg drive. It allows only a safe amount of current to flow through the third electrode.ECG signals vary from microvolt to the millivolt range. Due to this small range, the signals measured need to be amplified in order to be better interpreted [7]. Texas Instrument's instrumentation amplifier INA321 EA is used here.With an internally set gain of 5, the INA321 can be programmed for gains greater than 5 [8]. The last stage of the acquisition system is the analog to digital converter (ADC).Atmega 328 microcontroller by Atmel is used for this. It has 6 channel 10 bit analog to digital converter which converts from ground (0 V) to 5V.The value range from 0 to 1023 that

means it have 10 (2^{10} = 1024) bit resolution[9]. Output of filter is connected to analog pin of microcontroller. Arduino open source software is used to program the Atmega microcontroller. Figure.3 shows the Hardware of ECG Acquisition system.The output serial data from the microcontroller is then converted to USB standard using FT232RL USB to Serial UART adapter. These signals are then transferred to PC using USB cable.
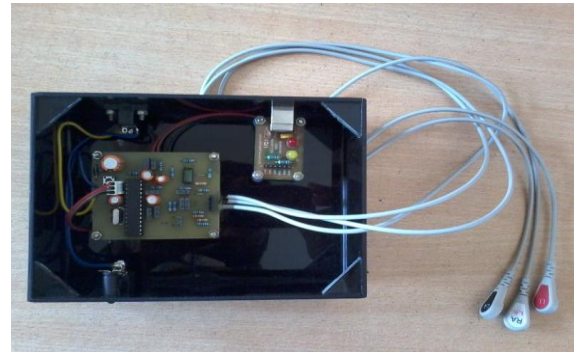

Figure. 3. ECG Acquisition System Hardware

Wireless Transmission

Zigbee technology is used in this work to transmit ECG signal from acquisition system to a laptop. It is a low-cost, low power, wireless mesh network standard which operates in the industrial, scientific and medical (ISM) radio bands [10].
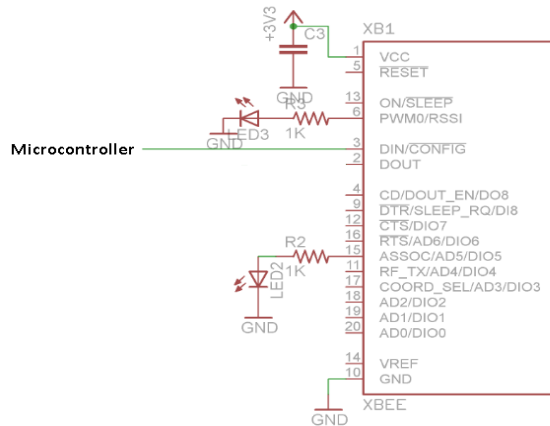

Figure. 4. Circuit diagram of transmitter

Circuit diagram of transmitter is shown in Figure.4.Analog ECG signals are digitized and converted to serial data by Atmega microcontroller. This serial data is fed to zigbee module and are then transmitted wirelessly using zigbee technology. Fig. 5 shows the hardware of ECG acquisition system interfaced with zigbee module.
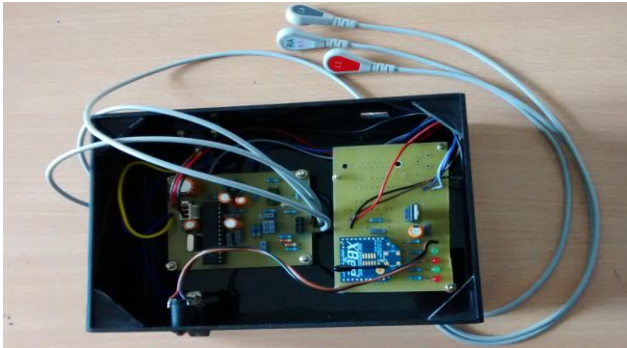
51

Figure.5 ECG Acquisition module interfaced with Zigbee transmitter module

Reception and Display of ECG Signal

The circuit diagram of receiver is shown in Figure. 6 Zigbee module and MAX232 IC are used. The received signal from the Zigbee module is TTL level, so it should be converted into RS232 level. For this level conversion MAX232 IC is used. The Signals from Zigbee module is connected to MAX232 IC where this TTL signals are converted to RS232 .The output serial data from MAX232 are fed to PC using serial connector DB9.For connecting to laptop FT232 can be used for serial to USB conversion. Figure. 7 shows the hardware for receiver section.
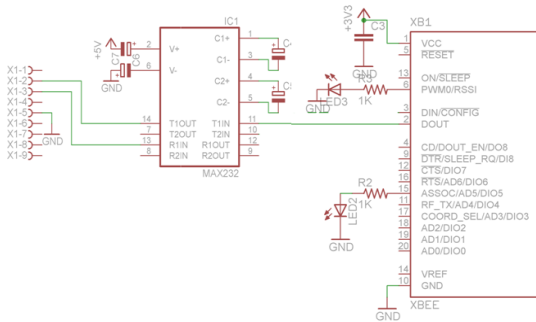

Figure. 6. Circuit diagram of receiver

Figure. 7. Receiver section hardware.

ECG Display on Laptop using Labview

Before plotting the ECG in the browser the signals are viewed in the laptop using LabVIEW. LabVIEW programs are called virtual instruments, or VIs,it consist of two windows a front panel and block diagram. Front panel contains controls and indicators.XY graph is used in this work to display the ECG in real time. The back panel, which is a block diagram, contains the graphical source code.Figure 8 shows the block diagram for receiving the serial ECG data and plotting it in real time.
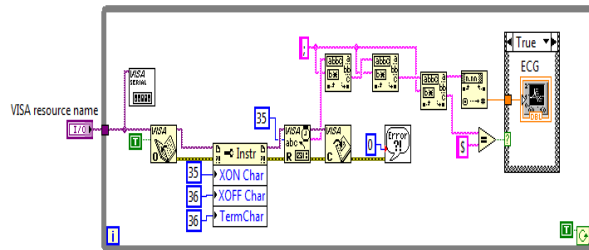

Figure. 8. Block diagram for ECG display in LabVIEW.

ECG Display on Local Server

ECG signals are wirelessly transmitted using Zigbee technology to a remote laptop.The serial ECG data received by the laptop are stored in the data base of the server. These signals are then retrieved and plotted in the browser of the system configured as server. The ECG signals are then viewed in another laptop using internet and the IP address of the server.WAMP Server is used in this work for configuring the laptop as server.It is a Windows OS based program that installs and configures Apache web server, MySQL database and PHP scripting language.This combination (Windows,Apache,MySQL,PHP) of software is known as WAMP[11]. JQuery is used to plot the ECG signal in real time in the browser of the server. JQuery is a fast Javascript library which simplifies HTML document traversing, event handling, animating and Ajax interactions for rapid web development and is an interactive kind of application [12] . Flot is a pure JavaScript plotting library for JQuery and is used in this work to plot the ECG signal.

Results

The ECG signal wirelessly transmitted using Zigbee technology is plotted and displayed in the laptop using LabVIEW software. Figure.9 shows transmitted ECG signal received and plotted in PC using LabVIEW. Fig.10 shows the ECG signal plotted in the browser of the laptop confi-

gured as server. It is plotted in the browser of the laptop by typing www.localhost/chart.html.
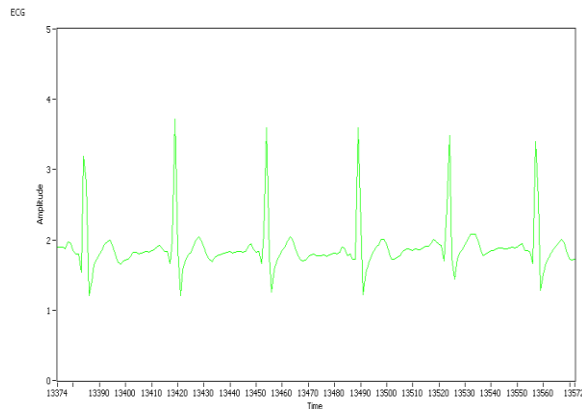

Figure. 9. Transmitted ECG signal received and plotted in PC using Labview
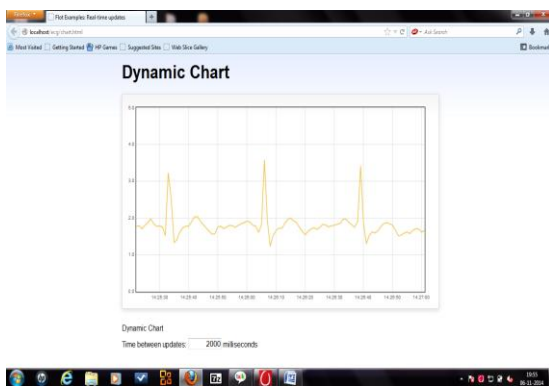

Figure.10.ECG signal plotted in the browser of the laptop.

ECG signals plotted in the local server are transmitted and plotted in a remote laptop using internet connection. The signals are plotted in the web browser of the remote laptop by typing www.internet protocol address (IP) of the local server/chart.html. Fig 11 shows the ECG signal plotted in the web server of remote laptop .
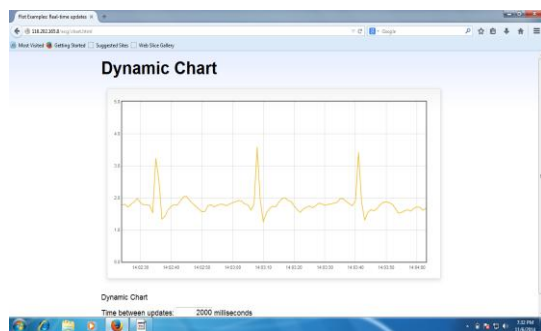

Figure.11 ECG Signal plotted in the web server of remote laptop.

Conclusion

In this paper ECG signal from ECG acquisition system is wirelessly transmitted to a remote laptop using Zigbee technology.ECG signals from the patient in the Cardiac Intensive Care Unit can be transmitted to any laptop or computer in the hospital by this method.The range of wireless transmission can be increased by mesh networking in which data are hopped from one node to other until destination is reached. The remote laptop itself is configured as server and the serial ECG data is stored in MySQL database of wamp server .Then these stored signals are plotted in the browser of the server and finally these signals are plotted in remote laptop using the IP address of the server.In this way the ECG signals can be viewed by doctors in the same hospital as well as an experienced doctor in a super speciality hospital using internet.

References

[1] Shraddha Chauhan and Bani Tamber Aeri, "Prevalence of cardiovascular disease in India and it is economic impact-A review," International Journal of Scientific and Research Publications, Volume 3, Issue 10, October 2013.

[2] A.C. Smith, M. Bensink, N. Armfield, J. Stillman and L. Caffery, "Telemedicine and Rural Health care Applications,"Journal of Post graduate medicine,Volume 51 Issue 4,December 2005.

[3] R. Ramu and A. Sukesh Kumar, "Real-Time Monitoring of ECG using Zigbee Technology," International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-3,pp.169-172. Issue-6, 2014.

[4] Bin Yu and Lisheng Xu and Yongxu Li , " Bluetooth Low Energy based Mobile Electrocardiogram Monitoring System,"Proceedings of the IEEE International Conference on Information and Automation, China 2012.

[5] S. Shebi Ahammed , Binu C Pillai, "Design of Wi-Fi Based Mobile Electrocardiogram Monitoring System on Concerto Platform," Procedia Engineering , Elsevier IConDM, 2013.

[6] Alfredo I Hermandez ,Fernando Mora Guillermo Villegas, Gianfranco Passariello and Guy Carrault,"Real-Time ECG Transmission Via Internet for Nonclinical Applications," IEEE Transactions on information Technology in Biomedicine,Vol.5,No.3,2001.

[7] Wu Baochun, Li Min, Yang Yaning and Zhang Weiwei, "ECG Acquisition Circuit Design Based on C8051F330," Proceedings of the IEEE-EMBS Interna-

tional Conference on Biomedical and Health Informatics,China,2012.

[8] INA321 Datasheet by Texas instruments.

[9] ATMEGA328 Data Sheet by Atmel Corporation.

[10] Zigbee/Xbee Data Sheet by Digi International.

[11] David Ipswich, "Setting UP a WAMP Server On Your Windows Desktop," Technology Now at Smashwords,2011.

[12] Samrat Vivekanand O Khanna, Mijal Mistry, "Impact of JQuery in Web Domain,"International Journal of Advanced Research in computer science and software engineering,Vol.1,Issue -1,2011.

Biographies

Ramu R, received the B.Tech Degree in Electronics and Communication from University of Kerala, India, in 2007, M.E degree in Communication Systems from Anna University Coimbatore, India, in 2010 and currently working towards Ph.D.at University of Kerala,India.Ramu R may be reached at mail2ramureghu@yahoo.co.in.

Sukesh Kumar A, received B.Tech in 1976 from University of Kerala, M.E(Tel.E) in 1988 from Jadavpur University and PhD in 1999 from PSG College of Technology,Bharathiyar University. He worked as UG and PG Dean at College of Engineering Trivandrum and worked as Principal,College of Engineering, Sreekrishnapuram, Palakkad. He was Director of LBS Centre for Science & Technology, Govt. of Kerala undertaking and Centre for Continuing Education, Govt. of Kerala Undertaking (CCEK). Received "Best Paper Award" in Biomedical Engineering at 21st National Conference (NSC 97) and 22nd National Conference (NSC 98).He published more than 175 papers in conferences/Journals. Presented Papers in International conferences at Malaysia, France and Egypt apart from various conferences in India. Dr. A. Sukesh Kumar may be reached at drsukeshkumar@yahoo.in