Wireless Transmission of Biomedical Parameters Using GSM Technology

Manita Rajput, Sadhana Pai, Umesh Mhapankar

Abstract—: Patient tele-monitoring is remotely monitoring the vital parameters of a patient and providing them to the doctor at a remote location, thus ensuring mobility of both patient and the doctor. In the present paper the physiological parameters such as Electrocardiogram, Heart rate, SpO_2 and temperature are obtained, processed and displayed in a graphical user interface. If anyone of the vital parameter go out of normal range than an alert message is generated and sent by the system via a GSM/GPRS modem to the authorized doctor. This work aims at enhancing the existing patient monitoring by facilitating wireless transmission and reception of the patient's data using GSM technology. Thus an expert –based health care can be provided to understaffed remote sites at crucial circumstances. This project is a part of improvements in the field of telemedicine using LabVIEW for Virtual Instrumentation.

Keywords- LabVIEW, Patient telemonitoring, SPO_2, electrocardiogram, GSM modem, JPG image

I. INTRODUCTION

Many developing countries suffer from an acute shortage of medical professionals, particularly specialists. As per the latest data of 2013, India stands at 67th rank amongst around 133 developing countries with regard to the number of doctors while in respect of number of nurses, India is at 75th rank [1]. There are only 4, 000 cardiologists and 1, 200 cardiac surgeons for a population of over a billion [2]. It has been reported that, on average, there are fewer than 10 doctors per 100,000 people in Sub-Saharan Africa, and 14 countries do not have a single radiologist [3]. In mostly all the developing countries, one doctor has to serve many hospitals and hence they are not available full time in a single hospital. The available specialists and services are concentrated in big cities, while workers in rural health care, who serve most of the population, are almost completely isolated from specialist services.. These patients have to travel long distances in order to be seen by a specialist cardiologist. The same issues are encountered by patients requiring many other types of treatments. In many cases, patients take the trouble of travelling for diagnostic purposes only.

Hence, there arises a need to improve the patient monitoring devices and make them more mobile. The medical world today faces two basic problems when it comes to patient monitoring,

1. The need of presence of healthcare providers round the clock present on the bedside of the patient and
2. The patient being restricted to bed and wired to large machines.

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In order to achieve better quality patient care, the above cited problems have to be solved. The first problem can be solved through telemedicine. Telemedicine can be defined as the delivery of health care and sharing of medical knowledge over distance using telecommunication means. The aim of telemedicine is to provide expert-based health care to understaffed remote sites through modern telecommunication (wireless communications) and information technologies. The power of telemedicine is the effective use of current technology to better services and fast treatment of ailing patients. The second problem can be overcome through virtual instruments.

Many researches have been going on to enhance the power of telemedicine using Virtual Instrumentation. The transmission of ECG or other clinical signals/data via communication channels has been implemented and reported in literature.

PC based ECG monitoring system are being designed and developed using LabVIEW, the most powerful high level software used to build virtual instruments[4] and [5].

It is possible to transmit the ECG signal by digitizing it and converting it into packets [6]. On the receiver's side the packets are retrieved and an analog signal is represented. But sampling, digitizing and recreating the graph on the other side will result in a different version of the signal which could be misinterpreted by the doctor.

Researches are being carried for transmission of real time ECG signal via voice channels at a low cost [7]. In this, the author has worked on the fact that the GSM codec captures the features of audio signal. The cost of such a system is very high and will not be affordable in the rural areas of developing countries.

Biomedical information is being transmitted using Zigbee technology [8], Bluetooth protocol [9] and wireless sensor nodes [10].

ECG measurement based system for web service architecture using LabVIEW has also been implemented [11]. Various illustrations have been shown to directly capture digital pulse oxymeter's waveform [12].

This research aims at transmitting the biomedical parameters such as critical values of ECG signal, temperature measurements, SpO_2 levels from the remote patient location to the cardiologist/physician using a standard GSM mobile phone. If the patient's temperature and HbO_2 and level and heart beat rate cross the threshold values, an alert SMS is sent on the doctor's mobile. The transmission medium of choice is the GSM network with an overlay of GPRS. The reason above are applicable to many of the developing countries because good mobile networks are already in place in these countries or such networks are maturing fast. Also, it is the most popular communication network having infrastructure throughout the globe.

The main objective of this work and the proposed application is to present a better health service for the patient especially for the critical cases.

II. SYSTEM REPRESENTATION

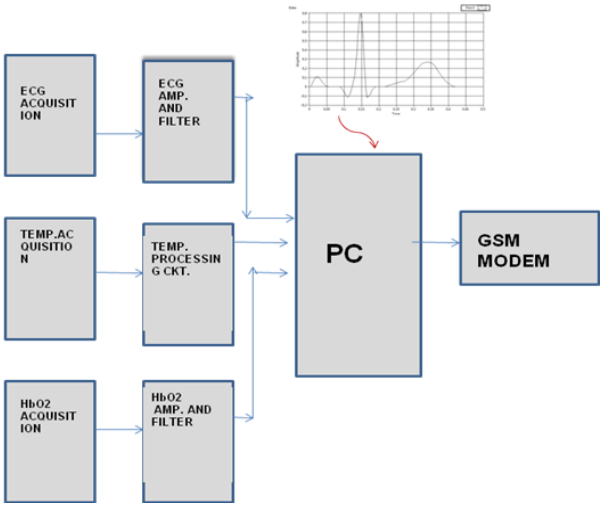

Figure 1.Block diagram of the system

The ECG, SPO_2, temperature is acquired, processed and fed directly to the PC. These parameters are then amplified, filtered and displayed on the front panel designed in LabView. The software compares the real time data with the presetted threshold values and if the threshold values are crossed,an alert SMS is sent via the GSM modem.

III. MATERIALS AND METHODS

This section discusses the basics of LabVIEW, signal acquisition, processing and transmission.

3.1 LabVIEW

The LabVIEW software is used as the integrating platform for acquiring, processing and transmitting the physiological data as it is an excellent graphical programming environment to develop sophisticated measurement, test, and control systems using intuitive graphical icons and wires that resemble a flowchart.

The software also includes number of advanced mathematics blocks for functions such as integration, filter and other specialized capabilities. The LabVIEW Professional Development System allows creating stand-alone executables and the resultant executable can be distributed an unlimited number of times. The run-time engine and its libraries can be provided freely along with the executable.

3.2 ECG Recording

Figure 2. Block diagram of ECG acquisition

The low noise ECG signal is acquired by Agcl electrodes, amplified with a gain of 2500, and filtered with a cut-off frequency 0.5-30 Hz. FilterPro software is used to design the low pass and high pass filters. The acquired signal is further processed by LabVIEW which is having signal processing module.

The appropriate filter and transform have been implemented and this gives noise free signal and from that fast and reliable estimation of clinically important parameter such as R-R interval and ECG peaks accurately achieved using LabVIEW.

3.3 SpO_2 Recording:

Pulse oximeter is a simple non-invasive method for monitoring the percentage of hemoglobin (Hb) saturated with oxygen (SpO2**)**.

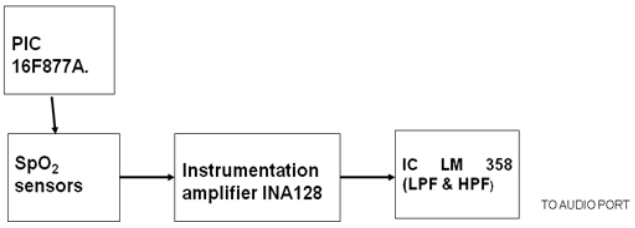

Figure 3: Block diagram for pulse Oxymetry

The sensors used are one IR LED, one Red light LED and a single photodetector. Their switching ON/OFF are controlled y PIC 16F877A microcontroller for precise timing generation of 5 seconds to trigger the IR and red LEDS consecutively. INA 128 is used for amplification of these pulsesThe gain set to 10. Output from this stage is applied to the low pass and high pass filter.

The filters have been designed using FilterPro software. The low pass filters are Sallenkey, Butterworth filter of the fourth order with a cutoff frequency of 50 kHz. The high pass filters are Butterworth filters of the fourth order with a cut off frequency of 1 kHz. LM 358 has been used to implement both these filters.

This setup is then connected to the audio port of the PC.

3.4 Temperature measurement

The temperature sensing is performed by using a DS18B20 which is a digital temperature sensor. It gives a nine bit binary output and can be directly interfaced with the PC through a simple circuitry.

3.5 Sending Alert messages via GSM

The modem used is SIMCOM900. This is a GSM/GPRS enabled modem which is capable of sending JPEG images as MMS which is the requirement of the project. It works on frequencies 850 MHz, 900 MHz, 1800 MHz and 1900 MHz. It is very compact in size and easy to use as plug in GSM Modem. The baud rate can be configurable from 9600-115200 through AT command.

The messages will be sent when

a. Armpit temperature crosses the range of 34.7-37.2 degree Celcius.
b. SPO_2 level crosses the range of 95-100%.
c. Heart beat is not in the range of 60-100 bpm.

IV. RESULTS

Figure 4 shows the acquired ECG on DSO

Measurement point	Amplitude (Practical readings)
I/P of preamplifier (INA 128)	Noisy and unmeasurable
O/P of preamplifier	50 mV
O/P of final stage amplifier	2.1 V

Figure 4.Output of ECG circuit on DSO

Table 1. Amplitude values of ECG signal

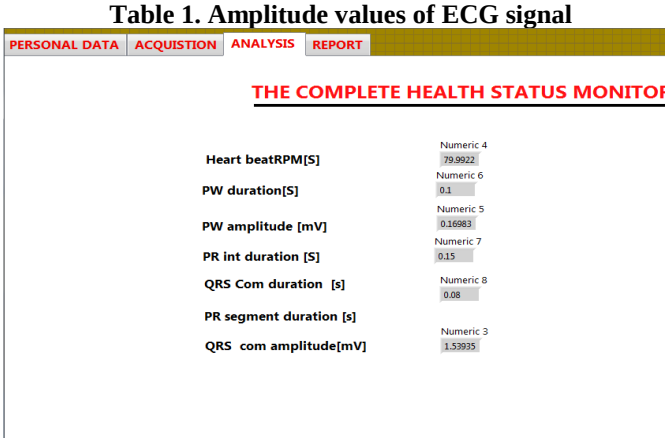

Figure 5. Analysis of simulated ECG

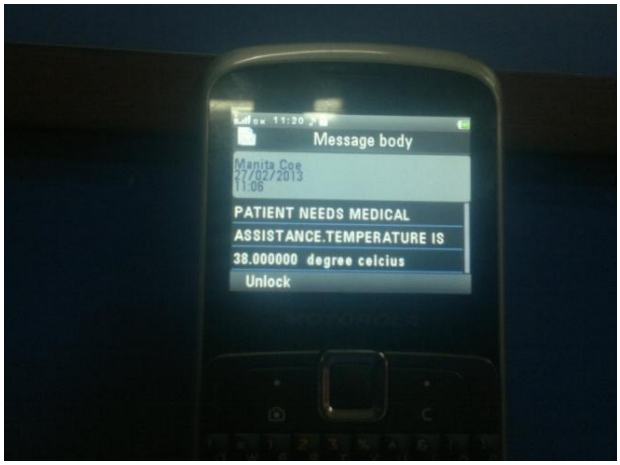

Figure 6.SMS recd. on doctor's mobile when temperature crossed the limits.

V. CONCLUSION

Work is in progress to send the jpg image of the ECG waveform to the doctor's mobile incase the QRS and P wave parameters cross the limits. Future scope of this work is as follows:

- More number of biomedical parameters can be acquired and analyzed.
- Instead of JPEG images, real-time ECG signals can be sent.
- The system can also be combined with a Web-based architecture, wherein mails will be sent to the respective doctors. Automated drug delivery can also be possible.

REFERENCES

1. www.pharmatutor.org
2. Article on 'India's top cardiologists' by Malathy Iyer , February 12, 2012. Hindustan Times
3. Editorial ,BMJ Volume 321 19-26 August 2008
4. "Development of PC based ECG monitoring system", Yin Fen Low (SCOReD 2006), Malasia.
5. Transferring ECG signal using GSM technology" Ahmed Khayamese, Palestine
6. "GSM based ECG tele alert system", R. sukanesh , International journal of Computer Science and Application Issue 2010
7. "Transmission of real time Clinical Diagnostic signals over the GSM network"tasneem Ibrahim Abdullah.2011 IEEE Student of Conference of Research and development.
8. "Wireless Biomedical System Design based on Zigbee technology for autonomous healthcare",
9. Nabil Hamza, INTERNATIONAL CONFERENCE ON COMMUNICATION, COMPUTER AND POWER (ICCCP'09),MUSCAT, February 2009.
10. "Wireless ECG using Bluetooth" a thesis report in the Masters of Engineering, Mumbai University.
11. "Real-time Heart rate Variability Detection on Sensor node",kinging Wong, Department of Electrical and Electronic Engineering, Curtin University of technology ,Miri,Malasia,IEEE Sensors Applications Symposium New Orleans, LA, USA-February, 2009
12. "A Smart ECG Measurement System Based on Web Service Oriented Architecture for Telemedicine Applications"Cladio De Capua,Member, IEEE,Antonella Meduri,Student Member, IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL.59, NO. 10, OCTOBER 2010
13. "Direct Digital Capture Of Pulse Oxymetry waveforms",John E. Scharf, Stephan Anthan,University of South Florida Department of Anesthesiology.