Int J Pharm Bio Sci 2015 Jan; 6(1): (B) 991 - 998

Research Article **Bioinformatics**

International Journal of Pharma and Bio Sciences **ISSN 0975-6299**

FPGA BASED PATIENT MONITORING SYSTEM USING SOPC

N.SURESH*[1] AND T.SASILATHA[2]

[1] Research Scholar, Department of Electronics and Communication Engg., Anna University, Chennai, India.
[2] Professor, Department of Electronics and Communication Engg., S.A. Engineering College, Chennai, India.

ABSTRACT

In this paper, a new method of patient monitoring system has been proposed by employing a system on programmable chip (SOPC) using field programmable gate array (FPGA) processor, due to drawbacks in embedded based patient monitoring system. SOPC based FPGA system measures multiple bio-signals such as Electrocardiogram (ECG), saturation level of oxygen (SaO_2) in hemoglobin, body temperature and it also analyzes the critical data of above parameters and transmits the abnormal data via short message service (SMS) to healthcare unit or personal doctor for diagnosis. This system achieves low cost and low complexity patient monitoring system.

KEYWORDS: SOPC, SaO_2, FPGA, Global system mobile (GSM), Global positioning system (GPS) and Critical data.

N.SURESH
Research Scholar, Department of Electronics and Communication Engg., Anna University, Chennai, India.

***Corresponding author**

INTRODUCTION

Electrocardiogram is a traditional method used for the diagnosis of heart diseases for about a century[1]. As per the statistics taken by medical council, Government of India, cardiovascular heart disease causes nearly 80000 deaths per year and affects 274 peoples per day its very dangerous and highly risky diseases[2]. Most of the elders will get heart disease with their ages above 60 years. Hence every day number of patients admitted in hospital increases but it is very difficult to increase hospital facilities such as number of bed and doctor requirement. Hence we need to go for an alternative solution to optimize these problems by using Telemedicine system (medicine from the distance). Telemedicine had been introduced by the Medical Research Centers in USA[3]. In telemedicine system, patient data had been transmitted from one place to another place using wire and wireless network. An ECG patient monitoring systems had been introduced where the output data was transmitted to receiver end through Global System Mobile (GSM) employing a microcontroller-based system[3]. The drawback of a microcontroller system consumes more power which in turn increases battery size which reduces speed of data transmission. Hence, it is difficult to reconfigure the microprocessor which overloads the patient's record. Heart-related diseases such as ischemia, myocardial infarction, arterial or ventricular fibrillation, ventricular tachycardia, heart block and AV block force all patients to receive immediate treatments and close aid, because these heart-related diseases often take their toll forcefully and suddenly[4]. Hence, medical technology has been computerized to provide patients with medical treatments and healthcare services through various communication systems. For example, the telephone and the Internet gain the highest popularity nowadays. Heart diseases are classified as follows; Electrical heart disease and circulatory heart disease. Electrical heart disease is characterized by abnormal heart rhythms, called arrhythmias, caused by problems with the electrical system regulating the heartbeat. An arrhythmia may be indicated if the cycles are not evenly spaced. Computer based analysis of Electrocardiogram (ECG) are not completely equipped for Arrhythmia analysis. The earlier method of ECG signal was based on time domain Method[5]. Circulatory heart disease caused due to blood vessel disorders, high rate of heart beats per minute, SaO_2 and body temperature which results in stroke or heart attack. Hence, the above parameters play a major role for developing heart related diseases in human bodies In this paper, we propose SOPC-based wearable patient monitoring system. It overcomes the drawback of embedded-based system. The proposed system helps to diagnose heart-related diseases for poor patients in rural areas. This system also develops hardware equipment that warns the patient's abnormal such as heartbeat, SaO_2 and body temperature. Whenever the patient is in abnormal condition, the SOPC-based system transmits the warning message using global system mobile (GSM) and patient's locations using global positioning system (GPS) to concerned physician and their attendee to help the patient in remote area to save the life of patient in short time.

The benefits of proposed scheme

- The benefits of proposed scheme:
- No need of personal computer.
- The risk of infection gets reduced.
- Clinicians can check data in a short time and also easily diagnose the disease by the use of critical points.
- Cost is decreased significantly.
- There is no loss of data during transmission.
- Small size, low power consumption, less weight, high speed of data transmission and its wearable device by use of SOPC.

SYSTEM DESCRIPTION

The structure of proposed system is shown in Figure 1, and it contains three major layers.

Block diagram of Patient monitoring system

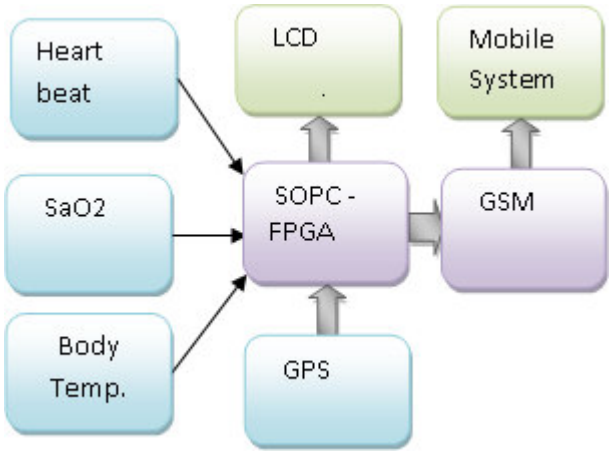

Figure 1

The first multiple sensor layers were used to measure the different bio-signal from the patient's body. The second processing layer (FPGA) which receive the signal from multiple sensor and analyze the critical points of multiple bio-signal by conditional algorithm and then pass the signal to communication layer. The communication layer transmits the important abnormal critical data to authorized healthcare service or personal doctor via mobile phone network.

PROTOTYPE OF SOPC-(FPGA)

Prototype of FPGA based patient monitoring system

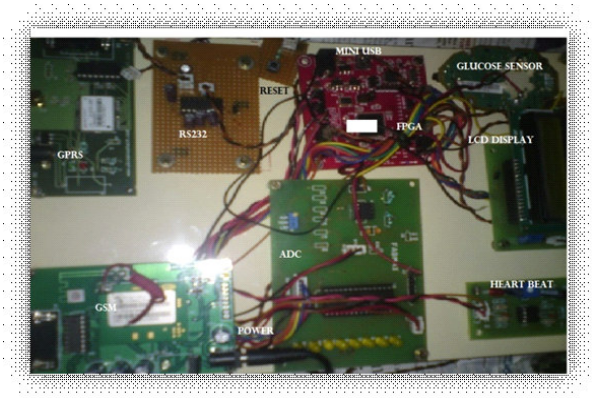

Figure 2

The Spartan-3E FPGA family is used to process the data and find irregular in heart beat, SaO_2 and body temperature using decision algorithm. From the guidance of medical specialist the data are analyzed and find normal and abnormal rate of heart beat, SaO_2 and body temperature. Table I provides data of normal and abnormal level in multiple bio-signal.

Table 1
Normal and Abnormal rang of multiple bio-signals

Bio logical data	Normal Range	Abnormal Range
Heart beat	60-100 b/m	<60 & >100 b/m
SaO2	95%	<90 & >100%
Body Temperature	60 to 90 F	<50 & >100 F

PROCESSING UNIT

The processing unit consists of four subgroups, such as processor chip, GSM, GPS and LCD. The processor unit receives the multiple signals and determines whether the condition is normal or abnormal. If any abnormality is detected, then the system will immediately send the warning message to the receiver mobile using GSM and also display the result in LCD display in patient side, Here the GPS module is used to predict the location of patient and transmit the details to the receiver.

System Module of Programmable Chip

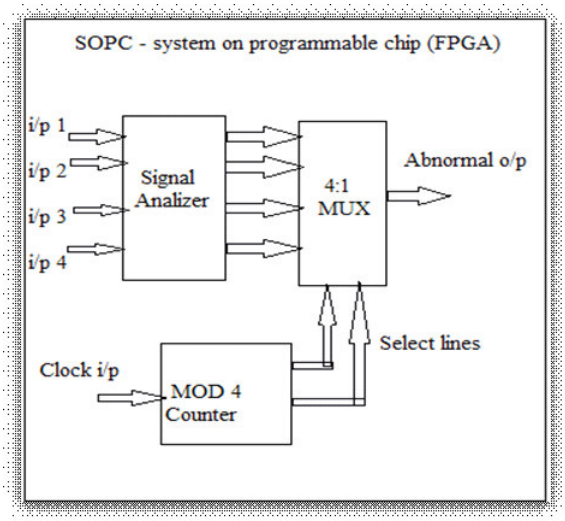

Figure 3
shows the internal structure of SOPC (FPGA). The physical structure consists of all programming module in a single chip by using Modelsim and Quartus software.

The multiple sensors connected to the patient body manually to get ECG, SaO_2 and Temperature levels. The processor receives the input from the sensor module continuously by Bluetooth connection and it converts the analog signal to digital form and it analyzed by signal analyzer. The analyzer block analyzes the bio-logical data and finds the normal and abnormal conditions as per threshold level fixed in the software coding, this output given as a input of 4:1 multiplexer (mux). The MOD4 counter used to control the multiplexer, The counter receive the continuous input clock pulse from the clock generator and generate the output of 00,01,10 and 11 and repeat the same as per delay given to a clock generator. The counter output is given to multiplexer as select lines, If the multiplexer select line is 00 it select the first input of ECG conditions which is abnormal, the data to be sent to receiver mobile through GSM and also activate the GPS to locate the place of patient. When the second counter output 01 is given to multiplexer select lines, now the second input of SaO2 status is updated to doctor through SMS if it is abnormal. Similarly for select line input 10 and 11, the warning message sent to doctor if third and fourth parameter is in abnormal state. Again repeat the process as per control time given to produce the clock signal

GLOBAL SYSTEM MOBILE

Global system mobile communication is a globally accepted standard for digital cellular communication. The GSM-ECON SIM300-V7.03 module is used to communicate mobile phone network. This GSM module is used to send critical data as a short message to healthcare service or doctor mobile if any one multiple bio-signals are abnormal.

GLOBAL POSITIONING SYSTEM

Global positioning system is used to locate a position and its equivalent global time on the whole earth's surface. The GPS satellite passes the altitude, latitude and height of any location on the earth surface to the earth station. The satellite earth station then uses these three parameter values and calculates the actual location of the place on the earth surface. Based on these concepts Doctor or caretaker identifies the patient's location and give for immediate treatment.

RESULTS AND DISCUSSION

The experiments was conducted to test the accuracy of heart beat, SaO_2, body temperature and also to detect the abnormal rate.

SIMULATION RESULTS

Simulation output of the proposed system

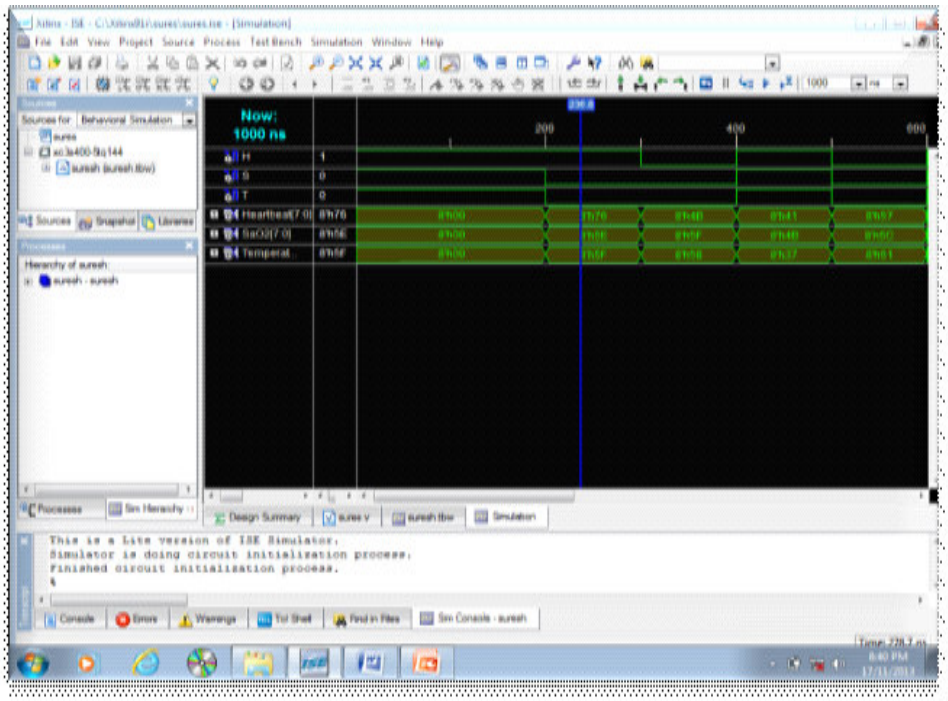

Figure 4

shows the simulation output of the proposed system. This receives the input data of Heart Beat rate, SaO2 and body temperature and analyzes whether it is normal or abnormal level based on processor coding and waveform is generated. Here 0 in output waveform shows normal and 1 in waveform shows abnormal condition

EXPERIMENTAL RESULTS

Warning Message at the Device

Figure 5

The output warning message displayed in the LCD display. For example if the heartbeat is less than 60 the device shows the warning message as 'Heart Rate Low', or else if the heartbeat is greater than 100 it displays the warning message as 'Heart Rate High' which is depicted in Figure 5.

The processor also sent the abnormal status to the Doctor mobile through GSM, shown in figure 6. This is the warning message of low heart beat 52 b/m.

Warning message of heart rate when it occurs as a low value as less than 60 B/M in receiver mobile.

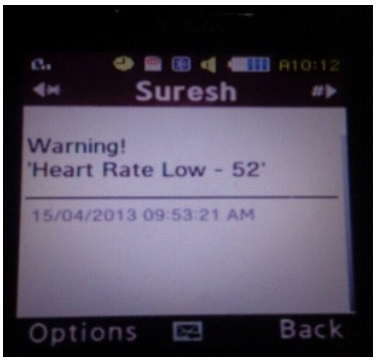

Figure 6

the Warning message of heart rate when it occurs as a low value as less than 60 B/M in receiver mobile.Warning message of heart rat when it occurs high value as greater than 100 B/M in receiver mobile.

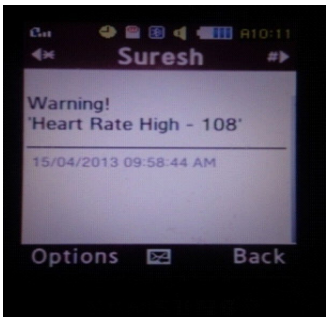

Figure 7

The Warning message of heart rate when it occurs as a high value as greater than 100 B/M in receiver mobile.

Heart disease patients nearly 40% of the people die even before they reach the hospital for treatment. Therefore delay in reaching a hospital proves to be fatal. Hence it becomes important to find the success rate of our prototype in delivering the SMS to the patient's caretaker and doctor and to find the average time taken between sending an SMS from the hand held device to receiving the SMS at the doctor end. This work is implemented with the real time clock present in the FPGA processor. Whenever an SMS is sent during an abnormal condition, the time of the processor clock is also sent along with the message.

Table 2

Shows the end time at which SMS was sent received

Bio Logical Data Condition	SMS Initiated Time (H:M:S)	SMS Received Time (H:M:S)	Time Taken Between Transmission And Reception (H:M:S)
Heart beat rate (Abnormal)	09:53:28	09:54:52	00:01:24
	09:58:01	09:59:57	00:01:56
	10:11:26	10:13:00	00:01:34
	10:18:36	10:20:05	00:01:29
	10:49:10	10:51:04	00:01:54
SaO2 (Abnormal)	09:56:12	09:57:55	00:01:43
	10:01:47	10:03:46	00:01:59
	10:05:51	10:07:12	00:01:21
	10:08:34	10:09:35	00:01:01
	10:09:58	10:11:09	00:01:11
Body Temperature (Abnormal)	10:13:46	10:14:16	00:00:28
	10:15:12	10:16:23	00:01:11
	10:22:35	10:23:37	00:01:02
	10:34:11	10:35:21	00:01:10
	10:46:51	10:47:58	00:01:07
AVERAGE TIME TAKEN			00:01:35

Table 2 Shows the end time at which SMS was sent received, the proposed SOPC-based FPGA system, the average time taken is reduced to 00:01:35 (H: M: S), whereas Average time taken by embedded-based (ARM Processor) patient monitoring system to send message to the receiver end is 00:02:12 (H: M: S)[6]. The cardiac arrest patient need medical care immediately, for these kind of patient's each and every second is valuable to save the life. In our proposed system abnormality analysis is done. After analysis, the information is sent to care taker or doctor by SMS in very short time. Hence, immediate diagnosis is done by the medical practitioner and gives the treatment at crucial time

.

Table 3
Shows the Comparison Table of time taken to send the message of abnormal patient's

S.No	Processor	Average Time Taken (H: M: S)
1	ARM Processor (Existing)	00:02:12
2	SOPC-FPGA Processor (Proposed)	00.01.35

CONCLUSION

There are many ways to increase the performance of proposed device, such as to design a single sensor to sense multiple bio-signals, The Psychological sensors data was sent to a FPGA processor for analyzing the normal and abnormal rate of heartbeat, SaO_2 and body temperature. If any abnormal data detected, the system sent a warning message to the patient's physician or relative with a short message service (SMS) via GSM module. This device also detects the patient location by use of GPS. This FPGA based SOPC system is reprogrammable structure. Hence, we can easily change the abnormal threshold rate with respect to the patient's condition.

REFERENCES

1. Stanislaw Osowski., Linh Tran Hoai., Tomasz markiewicz. Support vector machine-based expert system for reliable heartbeat recognition: IEEE Transaction on Biomedical Engineering. 51 (4): 582-589, (2004)
2. Satish G., Patil. Novel method for measurement of aortic pulse wave velocity by photoelectric pulse transducer coupled with ECG: A pilot study International Journal of Pharma and bio Science. 3: 653-658, (2012)
3. Thulasi Bai V., Srivatsa S K. Design of wearable cardiac telemedicine system: International Journal of Electronic Healthcare. 3 (3): 303-316, (2007)
4. Liu C S., and et al. Chaotic phase space differential (CPSD) algorithm for real-time detection of VF, VT, and PVC ECG signals: in 4th European Conference of the International Federation for Medical and Biological Engineering. 22: 18-21, (2009)
5. Fei Zhang., Yong Lian. QRS detection based on multiscale mathematical morphology for wearable ECG devices in body area networks: IEEE Transaction on Biomedical circuits and systems. 3 (4): 220-228, (2009)
6. Thulasi Bai V. Real time portable telemedicine systems for cardiac patients: International conference on Future Biomedical information Engineering. 57-60, (2009).