A Low Cost Human Body Parameters Measuring Device

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Abstract

This paper aims at designing a low cost human body parameters measuring device. The objective of the proposed work is to display the pulse rate and temperature of the human body. The data corresponding to the pulse rate is obtained with a low cost piezoelectric and for measuring temperature a temperature sensor LM35 is used. The outputs of these sensors are amplified and processed using the FPGA and the pulse rate and temperature corresponding to the human body is displayed using a LCD display. Initially the proposed technique is designed on LabVIEW platform. The processing is carried on using different tools of LabVIEW. The output pulse rate and temperature is displayed using a display. Indicator is green when the pulse rate is inside the healthy condition and red when outside the healthy range and same is implemented for temperature. After testing and validating the entire technique on LabVIEW platform. The entire code is converted to verilog code and dumped on to FPGA chip using FPGA module of LabVIEW with CompactRIO, for implementation of FPGA on real time system. The system implemented on FPGA chip is tested on human body for measurement of pulse rate and temperature and it was found that it measured parameters accurately as compared to existing systems.

Keywords: Piezoelectric sensor, temperature measure, FPGA, CompactRIO

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1. Introduction

Pulse is checked to see how well the heart is working. In an emergency situation, pulse rate can help to find out if the heart is pumping enough blood. Help to find the cause of symptoms, such as an irregular or rapid heartbeat (palpitations), dizziness, fainting, chest pain, or shortness of breath. Check for blood flow after an injury or when a blood vessel may be blocked. Check on medicines or diseases that cause a slow heart rate. Doctor may ask you to check your pulse every day if you have heart disease or if you are taking certain medicines that can slow your heart rate, such as dioxins or beta-blockers (like propranolol or atenolol). Check general health and fitness level. Checking pulse rate at rest, during exercise, or immediately after vigorous exercise can give important information about overall body fitness level.

The pulse rate is a measurement of the heart rate, or the number of times the heart beats per minute. As the heart pushes blood through the arteries, the arteries expand and contract with the flow of the blood. The normal pulse for healthy adults ranges from 60 to 100 beats per minute. The pulse rate may fluctuate and increase with exercise, illness, injury, and emotions. Females ages 12 and older, in general, tend to

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have faster heart rates than do males. Athletes, such as runners, who do a lot of cardiovascular conditioning, may have heart rates near 40 beats per minute and experience no problems. As heart pumps blood through the body, a pulsing sensation is felt in some of the blood vessels close to the skin's surface, such as wrist, neck, or upper arm. Counting pulse rate is a simple way to find out how fast heart is beating [1],[2].

The normal core body temperature of a healthy, resting adult human being is stated to be at 98.6 degrees Fahrenheit or 37.0 degrees Celsius. Though the body temperature measured on an individual can vary, a healthy human body can maintain a fairly consistent body temperature that is around the mark of 37.0 degrees Celsius.

The normal range of human body temperature varies due to an individual's metabolism rate; the faster it is, the higher the normal body temperature or the slower the metabolic rate the lower the normal body temperature. Other factors that might affect the body temperature of an individual may be the time of day or the part of the body in which the temperature is measured at. The body temperature is lower in the morning, due to the rest the body received and higher at night after a day of muscular activity and after food intake [3],[4].

The paper is organised as follows: after introduction in Section-1, a brief description on sensors used is given in Section-2. The block diagram of the proposed system is presented in Section-3. Section-4 deals with the problem statement followed by proposed solution in Section-5. Finally, result and conclusion is given in Section-6

2. Sensor

A: Piezoelectric sensor

A piezoelectric sensor is a device that uses the piezoelectric effect to measure pressure, acceleration, strain or force by converting them to an electrical signal. The Piezoelectric effect is an effect in which energy is converted between mechanical and electrical forms. Specifically, when a pressure (Piezo means pressure in Greek) is applied to a polarized crystal, the resulting mechanical deformation results in an electrical charge. When an electrical charge is applied to a polarized crystal, the crystal undergoes a mechanical deformation which can in turn create a pressure which can be measured in terms of voltage [5],[6].

In order to utilize this physical principle to make a sensor to measure force, we must be able to measure the surface charge on the crystal. Two metal plates are used to sandwich the crystal making a capacitor. As mentioned previously, an external force causes a deformation of the crystal results in a charge which is a function of the applied force. Piezoelectric crystals act as transducers which turn force, or mechanical stress into electrical charge which in turn can be converted into a voltage. Shown in Fig.1(a)

B: LM35

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. LM 35 has a scale factor of .01V/^{o}C. The LM35 does not require any external calibration or trimming and maintains an accuracy of ±0.4 ^{o}C at room temperature and +/- 0.8 ^{o}C over a range of 0 ^{o}C to +100 ^{o}C. Another important characteristic of the LM35 is that it draws only 60 micro amps from its supply and possesses a low self-heating capability. The sensor self-heating causes less than 0.1 ^{o}C temperature rise in still air. Fig 1(b) shows the LM35 used for the proposed system [7].

Fig. 1: (a) piezoelectric sensor (b) LM 35

3. Block diagram

The system is divided into two parts first is the transmitter model as shown in Fig.2. This model consists of the sensors, processor, display and a transmitter. Here the transmitter is also incorporated in the system to transfer the data like pulse rate and temperature corresponding to the patient to a receiver away using wireless communication. This may help the patients who are bought by the ambulance after measuring the body parameters it can be sent to doctors away so that they can be prepared for emergency. The receiver module consists of a receiver and here its connected to a PC we can even use a display.

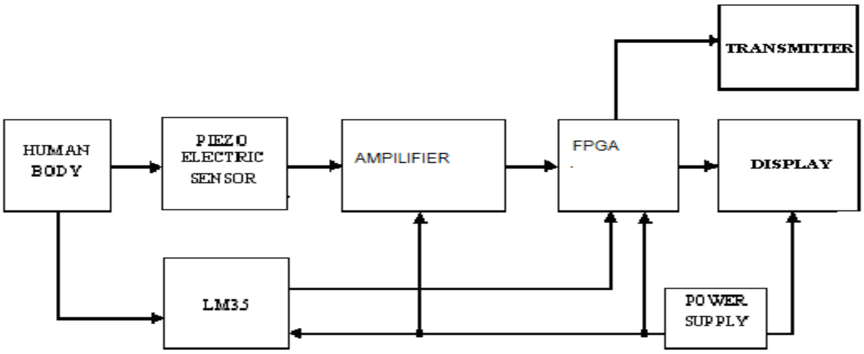

Fig. 3 Block diagram of transmitter model of the proposed measuring technique

From the block diagram it is clear that once the signal corresponding to human body parameters is sensed using the two sensors piezoelectric and LM35. The data is amplified and sent to the processor to perform action to display the pulse rate and temperature of the human body using the LCD display. The data is also transmitted to a receiver station using transmitter.

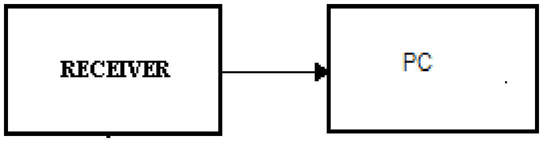

Fig. 4 Block diagram of receiver model of the proposed measuring technique

The proposed system before being implemented using FPGA it is first tested using LabVIEW. To perform the operation mentioned the data need to be captured to PC from the amplifier here for that purpose we use the NIElvis.

A: NI ELVIS

The National Instruments Educational Laboratory Virtual Instrumentation Suite (NI Elvis), as shown in Fig. 5, is a hands-on design and prototyping platform that integrates the most commonly used instruments. It includes oscilloscope, digital multi meter, function generator, bode analyzer, and more – into a compact form suitable for the laboratory experiments. It connects to PC through USB connection, providing quick and easy acquisition and display of measurements. Based on NI LabVIEW graphical system design software, NI Elvis offers the flexibility of virtual instrumentation and the ability of customizing any application [8],[9].

Fig 5. NI Elvis

In the proposed technique, the piezoelectric sensors after passing through the amplifier is connected to the analog input signal port (ACH0+ and ACH0-). Similarly temperature sensor LM35 after amplifying is connected to the analog input signal port (ACH1+ and ACH1-) of NI Elvis Further, with help of NI Elvis and LabVIEW software, the signal corresponding to pulse rate and temperature is acquired using DAQAssit of LabVIEW.

4. Problem statement

Once the signal corresponding to density and pH is acquired to the NIElvis, now the LabVIEW should be programmed to fulfil the following objectives:

a) Display the pulse rate
b) Display the temperature
c) Indicate the condition of health by an indicator.

5. Problem solution

The signals corresponding to pulse rate and temperature from the signal conditioning circuit is fed to the NIElvis pins of ACH0+ and ACH0-, ACH1+ and ACH1-. LabVIEW is used to accept the inputs from the NIElvis using the DAQAssit tool. The data once stored is processed, for displaying the temperature we use the equation relating output voltage of LM35 and temperature. For finding the pulse rate the output of the amplifier is compared using a zero crossing detector to get the signal in terms of square waveform then the number of cycles is calculated per minute to display the actual pulse rate of the human body. The whole data is then displayed on the front panel of the LabVIEW using numerical indicators. The front panel also contains indictors to display the condition of the health [10]-[14].

Fig.6 shows the picture of the front panel designed for the project. Fig.7 shows the block diagram.

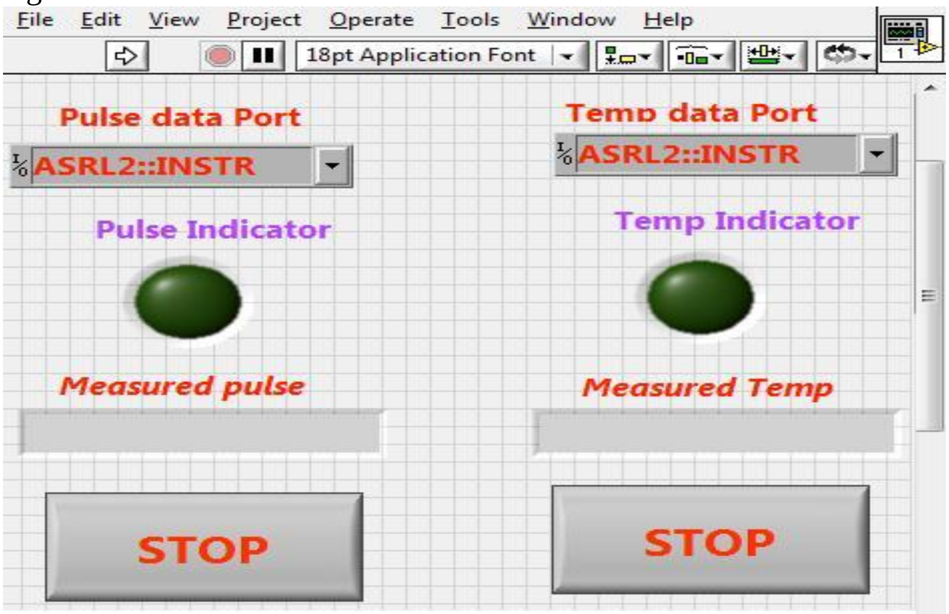

Fig. 6: Shows the front panel view of the proposed technique

The front panel consists of a start button which is used to start the process which means NIElvis is initiated to acquire signal from the sensors, two display indicating the pulse rate and temperature of human body, two indicator to indicate the whether the pulse rate and temperature ranges are under control when green it means the process in under control and when red it means the range are above the level indicated. The same is also indicated on a popup window.

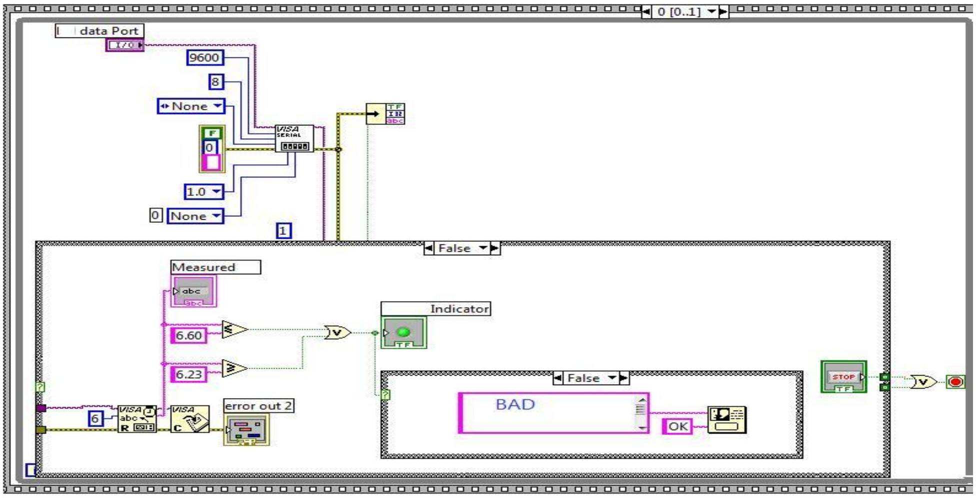

Fig.7: block diagram view of the proposed technique

Once the whole system is checked and validated using the LabVIEW platform the whole system is loaded on the FPGA with the help of NI CompactRIO. The Fig. 8 shows the hardware model implemented using FPGA. The system is now tested.

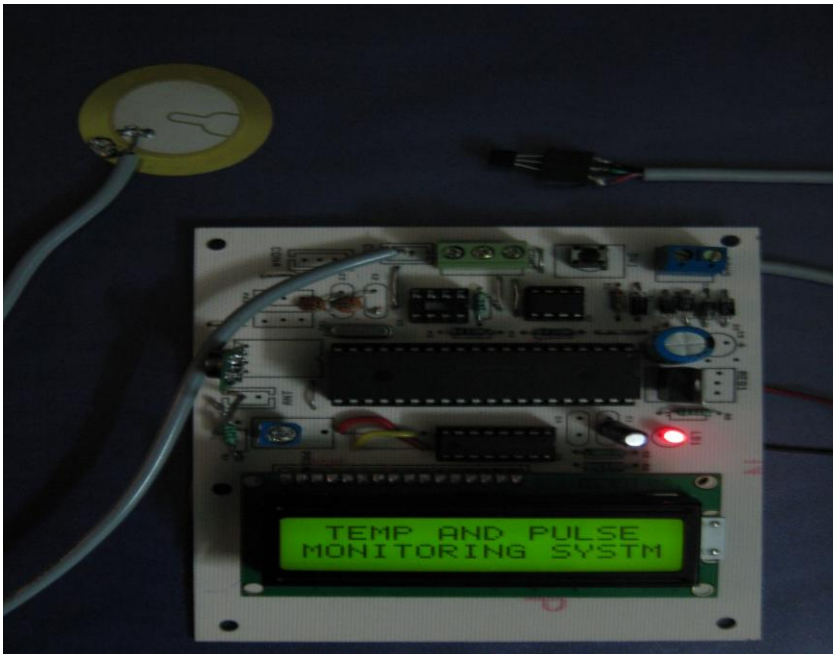

Fig . 8: Picture of the hardware model used for the proposed system.

6. Result and conclusion

The system after being implemented with FPGA was tested and the results are tabulated. Fig.9 shows the temperature result in comparison to the existing device. Fig. 10 shows the output of pulse rate measurement captured using CRO and Fig. 11 shows the pulse rate measurement in comparison to the existing setup.

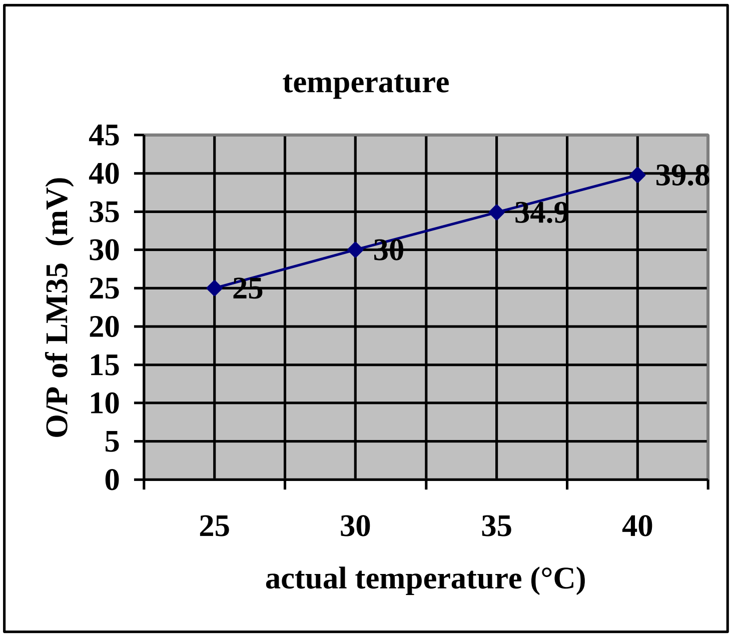

Fig. 9: Shows the result of temperature measurement

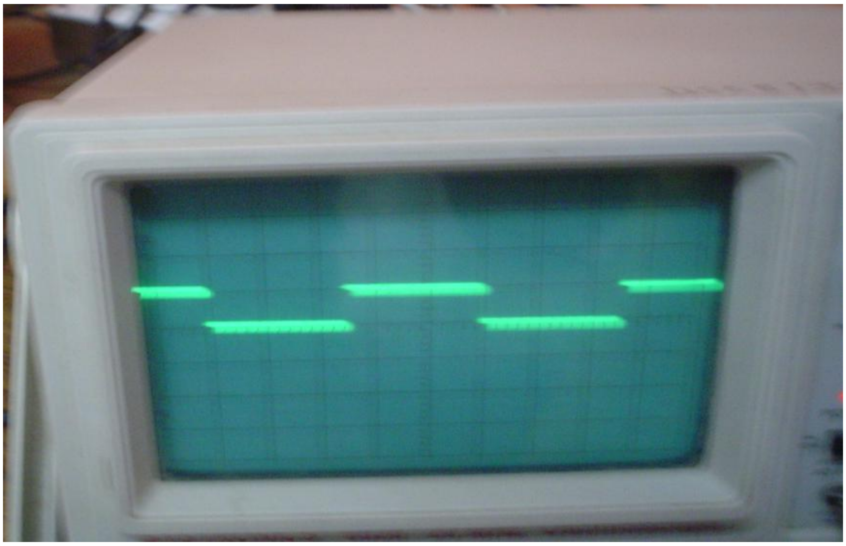

Fig. 10: CRO output for pulse measurement

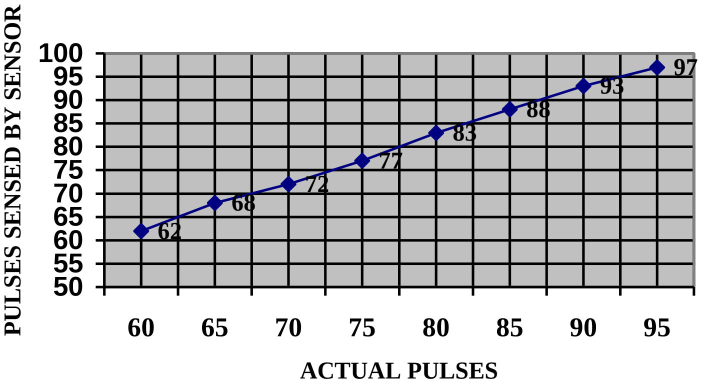

Fig.11: Show the result of pulse rate measure

The result shows that the present measurement technique is able to measure the human body parameters like pulse rate and temperature accurately. The advantage of the present technique is the economical factor of the system. The whole system was designed in a small amount of Rs. 200/- in the laboratory. This amount can be further reduced if manufactured in bulk.

References

[1]. Karvonen MJ, Kental E, Mustala O. The effects of on heart rate a longitudinal study. Ann Med Exp Fenn 1957;35(3):307-15.

[2]. Robergs R and Landwehr R (2002). "The Surprising History of the "HRmax=220-age" Equation". *Journal of Exercise Physiology* **5** (2): 1–10.

[3]. Elert, Glenn (2005). "Temperature of a Healthy Human (Body Temperature)". *The Physics Factbook*.

[4]. Laupland KB (July 2009). "Fever in the critically ill medical patient". *Crit. Care Med.* **37** (7 Suppl): S273–8.

[5]. Gautschi, G, "Piezoelectric sensorics" Publication Springer Berlin, Heidelberg, New York 2002.

[6]. Karki, James "Signal Conditioning Piezoelectric Sensors". Texas Instruments. September 2000.

[7]. LM35 Datasheet, National Semiconductor 1999

[8]. User Manuals, National Instruments Inc, USA, 2005.

[9]. Ventura J, Drake R, McGrory J, "NI ELVIS has entered the lab [educational laboratory virtual instrumentation suite]", Proc. IEEE SoutheastCon, Ft. Lauderdale, Florida, USA, 2005.

[10]. Mahesh.L.Chugani, "LabVlEW Signal Processing", Prentice-Hall India, 1998.

[11]. R. Bishop, *Learning with LabVIEW 7 Express*, New Jersey, Prentice Hall, 2004.

[12]. Changqing Cai, Feng Wang, Hong Dai, "The DAQ System of the Vehicle Test Based on the Virtual Instruments Technology", Proc. Int. Seminar on Future Biomedical Information Engineering, Wuhain , Hubei, China, 2008.

[13]. Kehtarnavaz N, Mahotra S, "FPGA implementation made easy for applied digital signal processing courses", Proc. IEEE Int. Conf. on Acoustics, Speech and Signal Processing, Pargue, Czech Republic, May 2011.

[14]. Guoqiang Wang, Tran T N, Andrade H A, "A graphical programming and design environment for FPGA-based hardware" Proc. IEEE Int. Conf. on Field Programmable Technology, Beijing, China, Dec 2010.