

DSP Based Wireless Reflectance Pulse Oximeter for Photoplethysmograms

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Abstract: Medical devices can be categorized into two categories which is invasive and non-invasive method. Invasive method needs medical device to be inserted into patient body regarding to check or do the treatment on the patients. However, the non-invasive method is a way to check the health condition from the outside of the body. A common non-invasive medical device is pulse oximeter. The function of the pulse oximeter is determining the percentage of oxygen in blood. Then, the based principle used to determine it is by calculating the intensity of transmitting light through the finger. Red and infrared light emitting diode (LED) is used to transmit the light and phototransistor works as a receiver. The hemoglobin in blood will absorb the light pass through the finger. Recently, there are many renovation has been made on this medical devices. Adding the parameter, showing the waveform of heart beat and wireless pulse oximeter are the new technologies on pulse oximeter. In this paper, the three parameters will be shown on the computer after go through the several parts. The ratio from intensity of red LED and infrared LED will be used to determine the value of heart rate and percentage of oxygen. The temperature sensor (LM35) also will be installed to obtain the body temperature. All the calculation and processing has been done by programmable board (Arduino Uno). Thus, the result would be appeared on the computer screen. The normal body temperature is about 37 °C and the normal percentage oxygen in blood is 95% to 99%.

Keywords: Photoplethysmograms, Pulse Oximeter, DSP, ADSP Processors, MATLAB.

1. Introduction

Nowadays, people are easily to be afflicted by diseases. They are merely concern about their healthy conditions regarding being busy with their jobs and lack of time to get medical check-up. The number of people who get diabetes, heart attack and other disease are increasing rapidly from day to day. These diseases can be prevented if the people make an early precaution to their healthy. One of the important term need to be taking care in body is percentage of oxygen in blood. The lack of oxygen in body will give bad effect to the body. Moreover, it can cause coma or strokes if the amount of oxygen is lack in the brain. The bad effect about lack of oxygen, it can cause death. The common diseases occur among the people who lack of oxygen in their body is hypoxia. It happens when the body getting less than 95% oxygen.

The blood oxygen level is an important indicator in medical equipment besides breathing rate, blood pressure, body temperature and heart rate. It gives basic information about body system especially in circulatory and respiration system. Other that, pulse oximeter widely used in operation theatre, emergency unit, neonatal unit, intensive care unit (ICU) and others at hospitals. Thus, this equipment is most important in the hospitals regarding give big impact to people.

2. Objective

ADSP Processor is used to measure Photoplethysmograms instead of microcontroller unit to improve signal stability, light emitting diode intensity auto regulation and MATLAB interfacing provide data visualization of heart rate. One limitation is that it makes the assumption that there are only two substances in hemoglobin, oxyhaemoglobin and deoxyhaemoglobin. It can be seen in Figure that there are

also other components of hemoglobin, including carboxyhaemoglobin and methaemoglobin. However, under most circumstances, these substances will not affect the reading.

A second limitation is the photodetector used is susceptible to ambient light that can cause misreading. To correct for this, a form of shielding can be used or a measurement of the ambient light can be taken and then subtracted from the desired signal. Third, the pulsatile PPG signal is very small compared to the DC signal it is riding on. This can partially be corrected though the use of higher resolution A/D converters or brighter photodiodes. Low peripheral vascular perfusion, or a reduced level of blood in the limbs, can cause the signal produced to be too small to be reliably processed. As an additional feature the human body temperature can be measured continuously.

3. Features

A. ADSP PROCESSOR BOARD

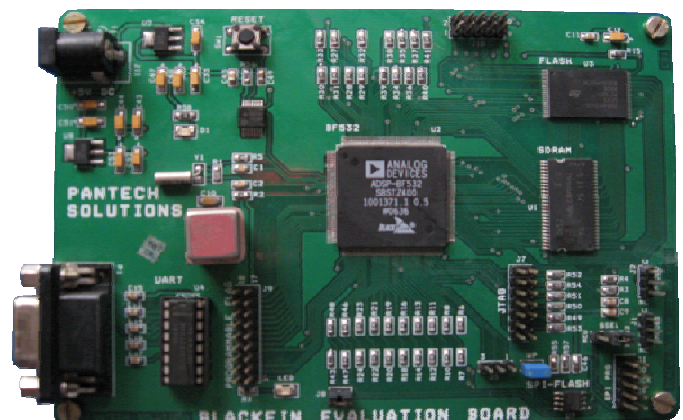


Figure ADSP Processor Board

The BF532EVB contains many connectors used for different Purposes. This section will explain the different components and connectors available in the Board. The Centre Part of the Board contains BF532 LQFP as the main unit. The other main peripherals shown with names are SDRAM (MT48LC8M16A2 from Micron) and a Parallel Flash (M29W160EB from STMicroelectronics).

B. The Board Features

- Analog Devices ADSP-BF532 Blackfin processor, Performance up to 400 MHz
- 27 MHz CLKIN oscillator
- Synchronous dynamic random access memory (SDRAM) ,MT48LC8M16A2 - 16 MB (8M x 16 bits)
- Flash memories 1 MB (512K x 16)
- SPI flash memory(2048 Kilobits) AT25F2048

- Universal asynchronous receiver/transmitter (UART), ADM3202 RS-232 line driver/receiver, DB9 female connector
- 1 LED
- Board reset
- Expansion interface
- JTAG ICE 14-pin header
- On-board 3.3V, 1.2V regulators

4. Methodology

A. Block Diagram

A block diagram of the circuit for a pulse Oximeter in Figure. The main sections of this block diagram are now described.

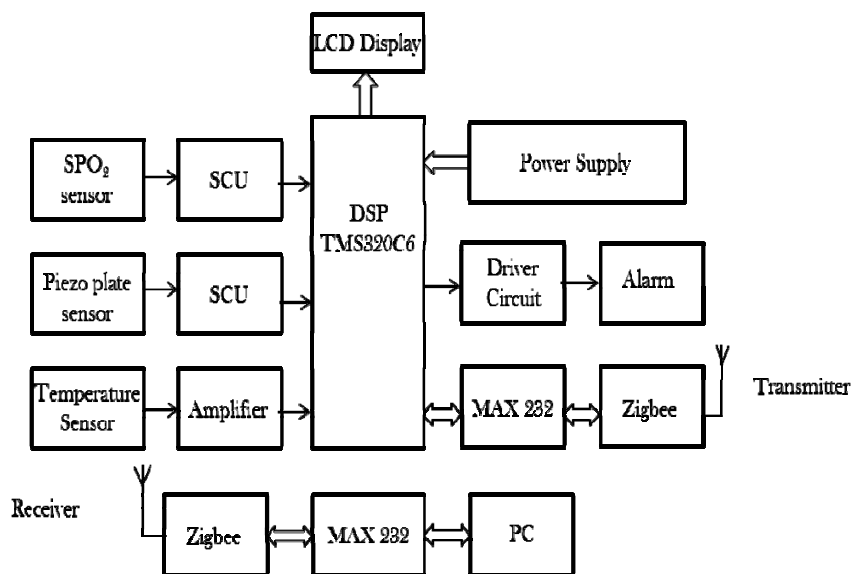


Figure Block Diagram of a Pulse Oximeter

B. Block Description

The SpO₂ sensor with signal conditioning unit consists of a light source and a photo detector. The light is shown through the tissue on the finger. As the blood passes through capillaries in the finger, the variation in blood volume causes a variation in the light detected by the phototransistor. The source and detector are mounted on either side of the finger to measure changes in transmitted light. In the paper, we used an infrared LED and Red LED. The ratio of these two absorptions will give us a SpO₂ level. This ratio number corresponds to the oxidization level of the blood. The signal conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter. This unit also accepts the digital sensor inputs and gives outputs in 10 bit binary with a positive logic level of +5V. The piezo plate sensor is connected with the wrist to produce additional information of the heart rate.

The temperature sensor is used to measure the human body temperature. The human body temperature signal is amplified by amplifier and it is given to the signal processor unit. The MAX 232 cable is interfaced with the signal

processing unit is connected with the Zigbee transmitter unit.

It transmits the collected signal to Zigbee receiver with receiving section at a frequency of 2.4 GHz. The PC interface with the Zigbee unit to provide the visualization of the respective waveform of heart pulse.

The output signal from signal processor is driven into the alarm unit for produce alarm for abnormal conditions. The suitable power supply unit is connected with the circuit to provide the supply to the processing units.

5. Results and Discussions

A. Calibration Of Temperature Sensor (LM35)

Before do the connection on the temperature sensor (LM35), the calibration on the sensor has to be made for getting the accuracy of the reading. The voltage output is linear with temperature value. By measuring the temperature of hot water using thermometer, then using the multimeter to measure the voltage output. It will perform a linear graph of temperature with voltage. Thus, the figure shows the result.

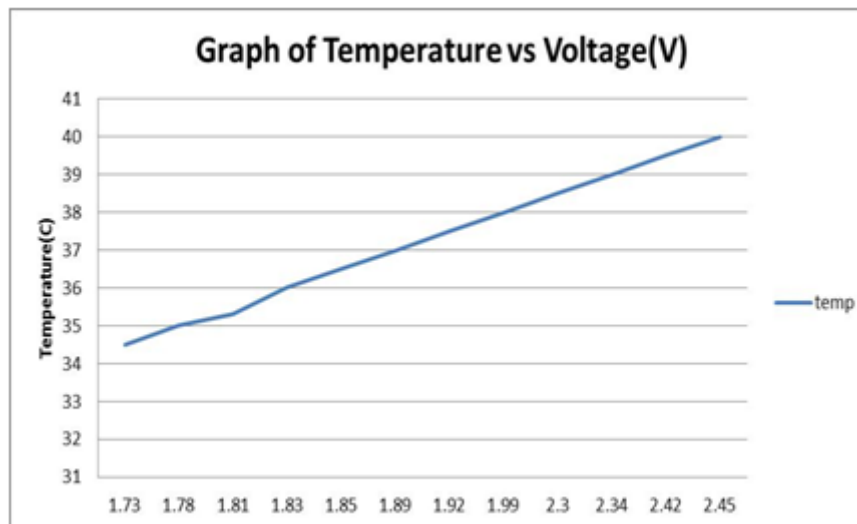


Figure Graph of Temperature versus Voltage

B. Result

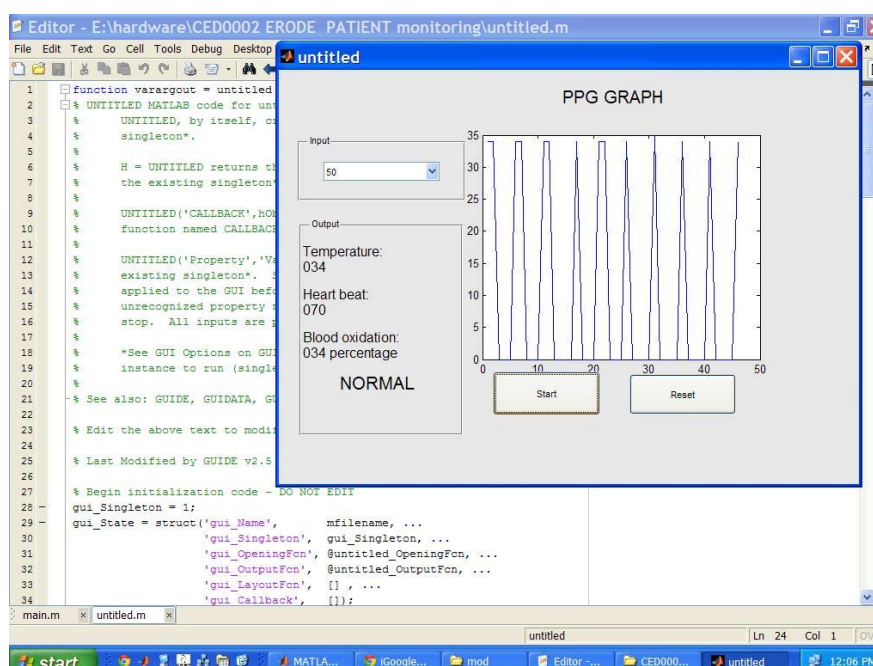


Figure The output reading

C. Discussion

In constructing the device and to perform programming task, this paper has faced some difficulties such as developing the software, testing the experiments also in troubleshooting parts. The infrared LED must be light if it is functional. By use phone camera, it can recognize either infrared LED functional or not. If the light appears when see it on the phone, so it is function. Encountering this problem is by changing the position of the feet of infrared LED. Then, the critical part is to design the coding of pulse oximeter in MATLAB coding programmer. The declaration of each component in the ADSP board must be right. If the declaration is wrong, the sensor can't detect the value, thus the reading will be wrong. Furthermore, in building the MATLAB Graphical User Interface, there were some problems to encounter. Each block diagram has the own properties and purpose. The diagrams have to be structured very well to prevent the error. The port to interface with

Arduino board must be correctly connected in Serial COM port number. Hence, the paper has their pro and cons in making the perfect device.

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