

Multiple Measurements of Blood by PPG Signal Using Lab VIEW

J.A.Monica Presanthy,
Control and Instrumentation Engineering,
J.J. College Of Engineering and Technology, Tiruchirapalli, India.

Abstract— The Blood oxygen saturation (SpO_2) is one of the important parameters that could be used to measure the ability of an athlete to participate in sports. Oxygen saturation rate can be measured with the help of invasive methods which uses the sample of blood as an input to detect the amount of blood that has been saturated. But this is the method which needs to make a protrusion in the human body to take a blood sample. Hence we are proposing non-invasive methods using optical and paramagnetic concept of measuring and analyzing PPG signal (Photo Plethysmographic signal). These methods measures the amount of hemoglobin (oxygen saturation) without any injury in the skin, hence could be made easier in its working and the way the result is produced. The sportsmen's Photo Plethysmography signal is continuously transmitted wirelessly through the ZigBee transceiver, whereas the ZigBee receives the signal from the photo sensor and transmits the signal as an input to the PC(Personal Computer); here the detection is performed using virtual programming, Lab VIEW. This project will be greatly useful for athlete selection committee, police and army men selections and also for clinical applications.

Keywords— Blood oxygen saturation (SpO_2), ZigBee, Photosensor, LabVIEW

I. INTRODUCTION

This project describes the device that measures and monitors oxygen saturation in blood, heart beat rate, respiration rate of human body wirelessly in order to find their fitness. Before learning the principles of the work, understanding of what the parameters are is very important. Oxygen is needed for life. Body cells need oxygen to perform aerobic respiration. Respiration is one of the key ways a cell gains useful energy. The energy released in respiration is used to synthesize the Adenosine Triphosphate (ATP) to be stored. The energy stored in ATP can then be used to drive processes requiring energy, including biosynthesis, locomotion, or transportation of molecules across cell membranes.

II. PLETHSMOGRAPHY

Plethysmography is the technique used to measure total amount of blood flowing and concentration of various components (AC pulsatile and DC non-pulsatile components) present in the blood. Concentration Amount of AC and DC components get varied according to the present of oxyhemoglobin and deoxyhemoglobin in the blood depends on respiration rate, this parameters can able to decide the fitness of particular person.

A. Photoplethysmography

Optical technologies are well suited for non-invasive Plethysmography monitoring of skin blood pulsation, that's why it is called as Photo Plethysmography. Photo Plethysmography is a non-invasive technique that measures relative blood volume changes in the blood vessels close to the skin. The pulsatile component (see Fig.1) of the PPG waveform is often called the AC component and usually has its fundamental frequency, typically around 1 Hz, depending on heart rate. This AC component is superimposed onto a large quasi-DC component that relates to the tissues and to the average blood volume. This DC component varies slowly due to respiration (i.e.) due to concentration of oxy and deoxyhemoglobin.

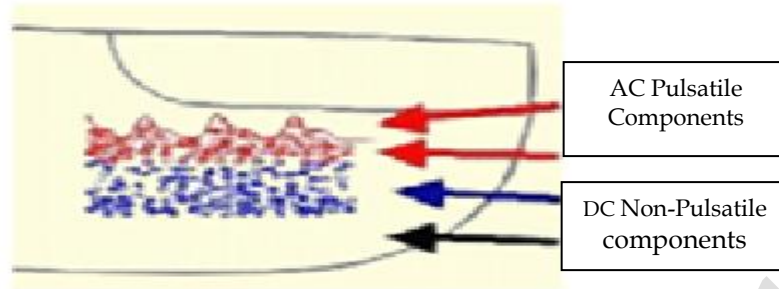


Figure 1: Components analysed by photoplethysmography in blood

III. MATERIALS AND METHODS

A. Measurement System

Optical method suggests about using two LEDs, Infrared LED (950 nm) and Red LED (660 nm). But we use those LEDs of specific wavelengths to acquire accurate results of saturation. The light signal passes through the human body and gets absorbed by the photodiode (850 nm). When seen in accuracy, the output obtained will be effective than the other methods discussed since particular wavelengths has been used to determine the rate of saturation and penetration power is also a main factor for this appropriate results. Paramagnetic concept is a major part of the project

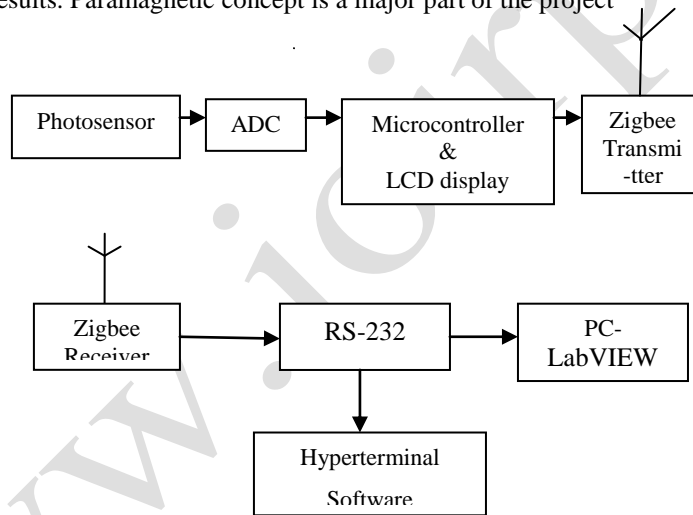


Figure 2: Block diagram for wireless SpO₂ measurement

Oxygen is a paramagnetic material that gets attracted in the presence magnetic field. More number of oxyhemoglobin gets attracted and hence we could able to get much more effective results than the other methods. To transmit the signals wirelessly the concept of ZigBee has been used. The analog signal from the sensor is interfaced with LabVIEW coding through the Data Acquisition Card (DAQ). The block diagram for wireless transmission is given in the Fig.2.

B. Methodology Of Photo-Sensor

When light is passed by the transmitter it spreads in a diffused pattern through the tissue. This transport is based upon the scattering and transmission characteristics of the tissue. The light then transmits to the receiver. Difference in the intensity of light

that is passed and the intensity of light that is received between oxyhaemoglobin and deoxyhaemoglobin is collected as output signal.



Figure 3: Real time photo-sensor module

This difference in the intensity will be the direct measure of the blood oxygen saturation rate in a calibrated way.

C. Zigbee Wireless Transceiver Module

ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on an IEEE 802 standard for personal area networks. ZigBee devices are often used in mesh network form to transmit data over longer distances, passing data through intermediate devices to reach more distant ones. This allows ZigBee networks to be formed ad-hoc, with no centralized control or high-power transmitter/receiver able to reach all of the devices.



Figure 4: CC2500 ZigBee module

Any ZigBee device can be tasked with running the network. ZigBee CC2500 (see Fig.4) is a FSK /MSK Transceiver module. It provide extensive hardware support for packet handling ,data buffering,burst transmissions, clear channel assessment, link quality indication and wake on radio. Its data stream can be Manchester coded by the modulator and decoded by the demodulator. It has a high performance and easily to design your product. It can be used in 2400-2483.5MHz.

IV. DETAILS OF PROTOTYPE

The belt consists of slots to carry the Microcontroller, ZigBee Transmitter and Battery. The belt (see Fig 5) can be tied or strapped over the sportsmen's hip, so that it can hold the components tightly while the sportsman is in motion. The sensor module is connected to the microcontroller.

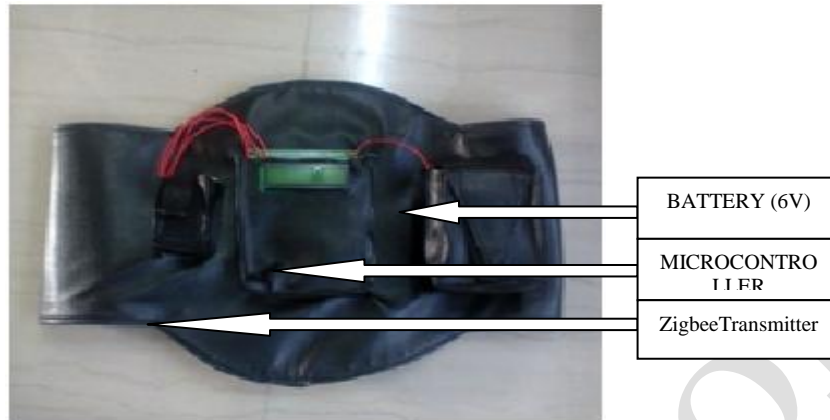


Figure 5: Sportsmen's hip belt

The data from the sensor module can be transmitted wirelessly while the sportsman is in running condition. The belt is adjustable according to the hip size of the people whom we are going to use.

V. RESULTS AND DISCUSSION

A. Formula For SpO₂ Measurement

The analog output signal obtained from photo-sensor contains AC-voltage & some DC-components imposed in it, the formula for obtaining SpO₂ rate is

$$\%SpO_2 = K \times R$$

$$R \left(\frac{(HBO_2)}{(HB)} \right) = \frac{AC_{(IR950nm, RED660nm)}}{DC_{(IR950nm, RED660nm)}} \quad \text{Where}$$

K-proportional constant,

The AC and DC estimator in LabVIEW provide solution to above formula, it can able to separate ac and dc components in analog signal obtained from photo-senor respectively. After estimating AC and DC value of red and IR led, the value of Ratio(R) can be determined, through which %SpO₂ can be found by multiplying ratio value with proportional constant.

B. Formula For Heart And Respiratory Rate Measurement

Heart rate can be found with peak values obtained from peak-detector and then Beat Rate Extraction Algorithm is used to do the further processing. BREAA states as follows:

- Heart rate = No. of peaks × 12
- Respiratory rate = Heart rate ÷ 2

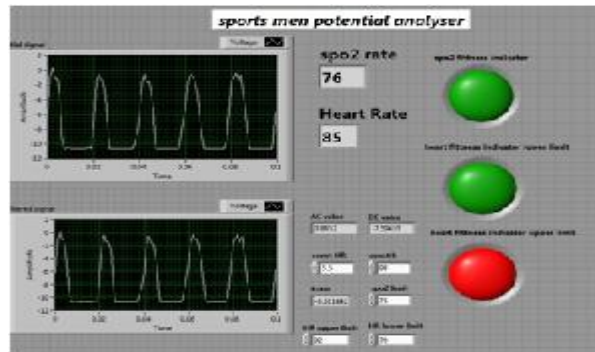


Figure 6: LabVIEW Results

Acknowledgment

I render my thanks to Mrs.M.Banusundareswari M.Tech., (Ph.D.,) Assistant Professor for giving valuable guidance to carry out my work.

References

- [1] Gu Bing, “Research of portable and Atraumatic Instrumentation of blood oxygen saturation degree to the movement of the test of physical parameters”, International conference on Future computer science and education, 2011, 978-0-7965-4533-2/11.
- [2] Laxmi Shaw, Sangeeta Bagha, “Real Time Analysis of PPG Signal for Measurement of SpO₂ and Pulse Rate”, International Journal of Computer Applications (0975 – 8887), Volume 36– No.11, December 2011.
- [3] G. Comtois, R.J. Duckworth, Y. Mendelson, “A wearable reflectance pulse oximeter for remote physiological monitoring”, EMBS Annual International Conference, Aug 30, 2006, 1-4244-0033-3/06.
- [4] Ankit Prasad, Bhavin Mehta, Dhivya Rengarajan, “Real Time Patient Tele-monitoring System Using LabVIEW”, International Journal of Scientific and Engineering Research, Volume 3, Issue 4, April 2012, ISSN 2229-5518.
- [5] Ben Goska, Brandilyn Coker, Caleb Cohen, Jerry Leung, Patrick Y. Chiang, Ryan Albright, Samuel House, “Wearable, Wireless Reflectance-Sensing Pulse Oximeter”.
- [6] H Ewald ,H Gehringand, J Krait, “An optical device to measure blood components by a photoplethysmographic method” Journal of Optics A Pure and Applied Optics.