

WRIST BAND PULSE OXIMETER

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ABSTRACT

Pulse oximeter is a medical instrument that can detect heart-rate and oxygen saturation as signatures of our level of health condition. It can be implemented as a miniaturized device, and therefore, has been used widely in different applications. The pulse oximeter basically is a non invasive technique used for calculation of oxygen saturation (SPO₂) of blood. The graph of oxygen saturation is called as Plethysmograph. The principle of pulse oximeter consists of two methods – Reflectance and Transmittance. Here we have used reflectance type where TCRT5000 sensor is used which has phototransistor & IR led. The red light should have the 600-750nm wavelength light band and infrared light should have 850-1000nm wavelength light band. The two stages of filtering and amplification converts the input PPG signals to near TTL pulses and they are synchronous with the heart beat.

Keywords : *Heartrate, Oxygen saturation (SPO₂), Reflectance method.*

I. INTRODUCTION

Optical technologies are well suited for non invasive monitoring of skin blood pulsation. Radiation of the red to near infrared spectral region penetrates several millimeter under the skin surface. Skin blood pumping and transport dynamics can be monitored at different body location (e.g. fingertip, earlobe, and forehead) with relatively simple and convenient PPG contact probes. Simultaneous data flow from several body locations the multi channel PPG technique increases the reliability of clinical measurements also allowing us to study heart beat pulse wave propagation in real time and to evaluate the vascular blood flow resistance an important physiological parameter for vascular diagnostics. Pulse wave analysis helps to study diabetes & arthritis & it is unique for each individual so it would also give unique identification as biometric identification. Pulse wave analysis also helps to

study large artery damage & an abnormality in the cardiovascular disease which is one of the common causes of high mortality rate. PPG analysis emphasizes the importance of early evaluation of the diseases.

The PPG waveform was first described in the 1930s. Although considered an interesting ancillary monitor, the “pulse waveform” never underwent intensive investigation. Its importance in clinical medicine was greatly increased with the introduction of the pulse oximeter into routine clinical care in the 1980s. Its waveform is now commonly displayed in the clinical setting. Active Research efforts are beginning to demonstrate a utility

beyond oxygen saturation and heart rate determination. Future trends are being heavily influenced by modern digital signal processing, which is allowing a re-examination of this ubiquitous waveform. Key to unlocking the potential of this waveform is an unfettered access to the raw signal, combined with standardization of its presentation, and methods of analysis. Human skin plays an important role in various physiological processes including thermoregulation, neural reception, and mechanical and biochemical protection. The heart-generated blood-pressure waves propagate along the skin arteries, locally increasing and decreasing the tissue blood volume with the periodicity of heartbeats. The dynamic blood volume changes basically depend on the features of the heart function, size and elasticity of the blood vessels, and specific neural processes. Therefore direct monitoring of skin blood pulsations may provide useful diagnostic information, especially if realized non-invasively.

II. METHODOLOGY

Photoplethysmography or PPG is a technique to measure the heartbeat that uses the ability of light to reflect and penetrate in human tissue. With every pulse the blood vessels increase in thickness and the body will therefore absorb more light as the light will have to travel through more tissue. PPG detects volumetric changes in arterial vessels that cause a change in the light absorption, reflection and therefore the light intensity detected by the photodetector. In most cases the measurement system consists of a LED, a photodetector and an electric system to filter and amplify the signal. What wavelength of light works best for a certain application is dependent on the type of tissue on which it will be used. Here we have used Reflective method which involves the reflection of light on a particular medium. Due to the measurement being done on the Wrist, and the invasiveness of the standard transmission PPG clip, the choice for reflection PPG is appropriate., the sensor would be flat on the skin on only one side, compared to both sides for transmission PPG. The reflective PPG can be done on the inner side of wrist. The analysis of the PPG signal may be the most important part of the monitor, because it needs to extract the heartbeat signal from the raw data, which includes a lot of ambient noise and motion artifacts.

PPG has a few limitations that limit the quality of the signal. There are different factors that influence the measured reflection and the possibility to filter the heartbeat.

- No other absorber exists for the measurement other than the arterial blood. However skin, bone, tissue and venous blood streams enhances the noise levels.

It has a relatively large DC component compared to actual PPG signal. A reduced blood level in the limbs can cause this signal to be undetectable.

- Ambient light susceptibility. The sensors typically used are a combination of an emitter and a photo detector. The photo detector is affected by ambient light. A solution for this could be to use a form of shielding, or to measure the ambient light and subtract this from the PPG signal.
- Motion artifacts. Motion causes changes in the reflected light received by the photo detector. This is the most important problem for reflection PPG. A small change in the reflected light will result in inaccurate measurements.

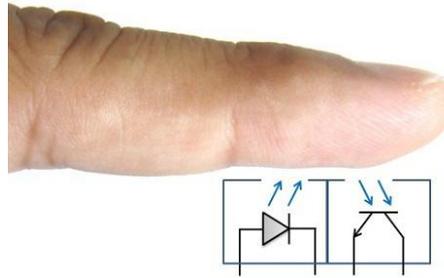


Fig 2.1: Reflection Type Method

III. PROPOSED MODEL

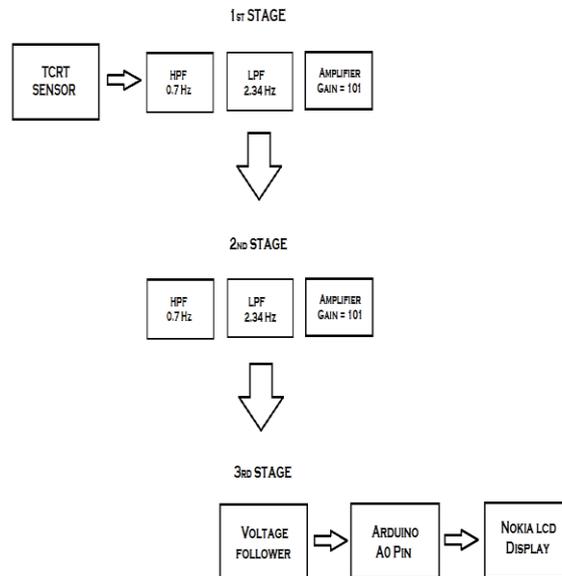


Fig 3.1 : Block Diagram

The TCRT5000 are reflective sensor which include an infrared emitter and phototransistor in a leaded package which blocks visible light. The package includes two mounting clips. This will be mounted on the wrist of hand. The signal conditioning and amplification circuit includes, the sensor output is first passed through a RC high-pass filter (HPF) to get rid of the DC component. The cut-off frequency of the HPF is set to 0.7 Hz. Next stage is an active low-pass filter (LPF) that is made of an Op-amp circuit. The gain and the cut-off frequency of the LPF are set to 101 and 2.34 Hz respectively. Thus the combination of the HPF and LPF helps to remove unwanted DC signal and high frequency noise including 50 Hz mains interference, while amplifying the low amplitude pulse signal (AC component) 101 times. The output from the first signal conditioning stage goes to a similar HPF/LPF combination for further filtering and amplification. So, the total voltage gain achieved from

the two cascaded stages is $101 \times 101 = 10201$. The amplified signal is then given to microcontroller (Arduino Ao pin) which will be displayed on Nokia lcd as a form of graph.

IV. SOFTWARE IMPLEMENTATION

The microcontroller program was developed in Arduino IDE, an open-source Arduino environment. This program is basically consisted by Three parts: Nokia LCD Oscilloscope display, oxygen saturation and heart rate.

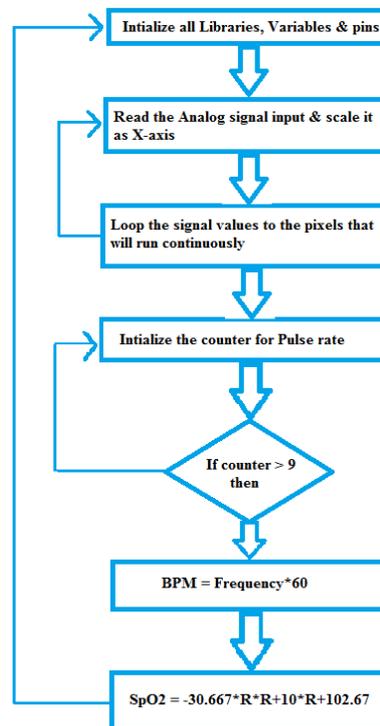


Fig 4.1: Algorithm

This algorithm works as follow: we first initialize the Libraries of Nokia 5110 lcd which includes PCD8544 48 * 84 pixels matrix LCD controller/driver. It is a low power CMOS LCD controller/driver, designed to drive a graphic display of 48 rows and 84 columns. The libraries named “Adafruit_GFX.h” and “Adafruit_PCD8544.h” were initialize at the beginning of program. Select input pins and variables to be used in program for nokia lcd read the analog values of pulses from analog pin of arduino and scale it on x axis with an potentiometer to adjust it. To show analog values in the form of graph draw a pixel using “display.drawPixel” and loop the signal values such that it will take new values according to the PPG of subject. The second part of algorithm consist of measuring pulse rate/heart rate which is done by using library “FreqMeasure.h”, the frequency of peaks of pulses is measured in every 10 counts and by multiplying this frequency to 60 we get the

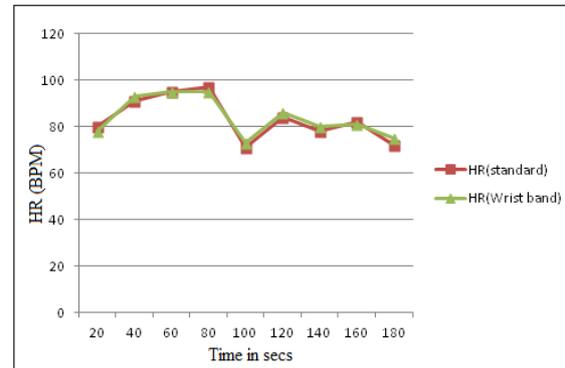
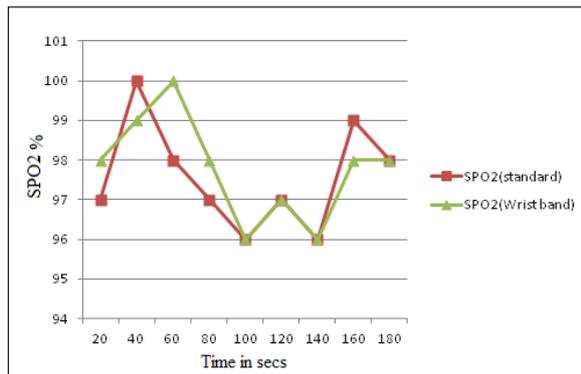
Beats per minutes (BPM).The third part of algorithm is calculating oxygen saturation. As we mentioned before, the principle of measuring oxygen saturation is that we alternatively emit two different wavelength lights (Red and Infrared light) to pass through human body then measure the absorption to calculate the oxygen saturation. The ratio is calculated by,

$$\text{Ratio} = \frac{\text{AbsorbanceRED}}{(\text{AbsorbanceIR} + \text{AbsorbanceRED})} \dots\dots\dots (1)$$

The SPO2 in percentage is calculated by using this ratio, $\text{SPO2\%} = 30.667 * \text{Ratio} * \text{Ratio} + 10 * \text{Ratio} + 102.67 \dots\dots\dots (2)$

V. RESULTS AND COMPARISON

STANDARD PULSE OXIMETER		WRIST BAND PULSE OXIMETER	
Clinical apparatus			
SPO2	HR	SPO2	HR
97	80	98	78
100	91	99	93
98	95	100	95
97	97	98	95
96	71	96	73
97	84	97	86
96	78	96	80
99	82	98	81
98	72	98	75



VI. CONCLUSION

The device is a prototype and can be taken for product development with addition module enhancements.

The device can also be used for continuously monitoring parameters of patients who are above 60-70 years and at risk of unpredictable health conditions such as having stroke, cardiac arrest and heart attack.

It can also be interfaced with the accelerometer which can be used to monitorise the parameters of sports athletes.

The bluetooth module can be interfaced with a wrist band and with the help of android application it can be displayed on a smart phone.

It can also be interfaced with GPS module & it would send the exact GPS coordinates of the person in need of medical attention.

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