Design of Ubiquitous Pulse Oximetry

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***Abstract*—In recent years, people have difficulty to breathe a good air quality. It is caused by vehicle emission, household combustion devices, forest fires, and industrial facilities are regular sources of air pollutants. These air pollutants can impair people health and behavior. It means that decreasing oxygen supply can reduce our immune system. The effect of reducing oxygen in our blood cause rapid fatigue, difficulty breathing, muscle pain, eye irritation and even more severe would have a heart attack. Monitoring peoples' health is one of solutions to increase the quality of human life. The pulse oximetry widely used to measure the oxygen level or oxygen saturation (SpO2) in the blood. While it has long been an important tool in clinical practice, pulse oximetry has become a popular medical tool for outside hospital environment use. Pulse oximetery work by the principles of spectrophotometry: the relative absorption of red (absorbed by deoxygenated blood) and infrared (absorbed by oxygenated blood) light of the systolic component of the absorption waveform correlates to arterial blood oxygen saturations. Patients usually take measure using pulse oxymetry in a stationary condition. While pulse oximetry recording a patient's oxygen level, the finger should not move until the recording is completed. The previous research have been evaluated a pulse oximetry in mobile condition. This paper will investigate the relationship between oxygen saturation and light attenuation in the proposed design of the ubiquitous pulse oximetry in mobile condition. This design will help the future development of SpO2 recording ability while patient in walking condition and give good accuracy as same as off-the-shelf pulse oxymetry.**

Keywords—Air Quality, The Ubiquitous Pulse Oximetry, SpO2

Introduction

In recent years, people in Sumatra, especially South Sumatra, Riau and Jambi frequently encountered environmental problems such as smog from forest fires. The haze in the air-quality environmental damage, especially us who need oxygen to breathe. In addition, the limited availability of oxygen from the environment, making it hard to breathe and lowered immune system. Because the oxygen content in the blood is reduced, causing rapid fatigue, difficulty breathing, muscle pain, eye irritation and even more severe would have a heart attack. This happens due to the current flowing in the human body, there are two cycles of blood. The first fresh blood or oxygenated blood pumped by the heart to the rest of the human body. All organs absorb blood oxygen carrier, so that the second cycle that is where the blood will return to the heart, the blood is no longer carrying oxygen. Therefore, the oxygen is very important for the body so that the levels found in the body (in the blood stream) should be maintained so that the human can live healthily.

The technology development has contribute to determine the oxygen levels in the blood (SpO_2) can use a device known as Pulse Oximetry. The work of Pulse Oximetry is to use the light source beam from the Light Emitting Diode (LED) that illuminates the infrared blood viscosity and is measured by the intensity of light received by a light detector (photo detector) [1]. There are two methods of sending the light pulse oximetry namely transmission and reflection. In the transmission method, a light emitter and detector opposite to each other by measuring tool between the light can then pass through the measured object is a finger. Then the next method is a method of reflection, the light emitter and detector are next to each other on top of the measurement pulse oximetry. Light bouncing from the emitter to the detector around the object to be measured [1]. In general, pulse oximetry connected by means of monitoring the use of cables. Some researchers propose a prototype pulse oximetry using a wireless network such as Bluetooth [2], the Wireless Sensor Network (WSN) [3, 4], and GSM [5]. Excess use of wireless technology is the ability to send data from the measurement, pulse oximetry become wider scope than using cable transmission media. But for Bluetooth network [2] and WSN [3, 4] does not have the range limitations that make it difficult when they are passing through the area coverage of the pulse oximetry to communicate with the central monitoring server. While the use of GSM network [5] has an extensive range because of the infrastructure Base Transceiver Station (BTS) which connects to the central monitoring server. Therefore, this study build a prototype of ubiquitous pulse oximetry which utilizes the advantages of the GSM network, but is able to provide early warning to the user to connect to a clinic or hospital as a monitoring center continously. The term "ubiquitous" is filed with the addition of the tool pulse oximetry just transmit critical information and network user's position using the Global Positioning System (GPS) and able to attach to human arm like a watch.

PULSE OXYMETRY

A pulse oximetry is a non-invasive method for monitoring oxygen saturation (SpO_2) of the hemoglobin. Today, pulse oximetry tool widely used in the health services that include intensive care, rehabilitation, recovery room, anesthesia patient monitoring [6]. Tools pulse oximetry allowing two different wavelengths of light (red, typically 550 nm and infrared, typically 950 nm) penetrate around the peripheral part of the patient's body, usually a fingertip or earlobe, and measure each wavelength of light is relatively reduced (R -ratio). Biological tissue is being measured consists of many elements, including capillaries, arteries and veins, skin and other tissue. Except for the arteries, reduced light by other network elements is relatively fixed. The transmission of light through the arteries is caused pulsation pumping of blood by the heart [6]. Pulsations of the arteries that carry oxygen levels are highest. Oxygen in the blood is largely shaped hemoglobin. Hemoglobin is 100% oxygen saturation within carry four oxygen molecules per molecule

of hemoglobin. Oxygen saturation of the blood as measured by pulse oximetry is a measure of the average percentage saturation of a population of hemoglobin. However, it does not measure the oxygen saturation for all parts of the body due to the limited pulse oximetry to measure hemoglobin oxygen saturation in tissue relatively thin, such as ears or fingers. Moreover, the pulse oximetry does not directly measure the concentration of hemoglobin in the blood that can lead to measurement errors if there is abnormal hemoglobin. For example, in the case of patients with anemia, low blood hemoglobin concentration, and pulse oximetry do not give an accurate indication of the amount of oxygen in the blood stream [6]. Pulse oximetry based on the principle of oxygenated hemoglobin (HbO_2) absorbs different light with deoxygenated hemoglobin (Hb), as shown in Figure 1. The meeting point is the wavelength absorption of hemoglobin two same formats [6].

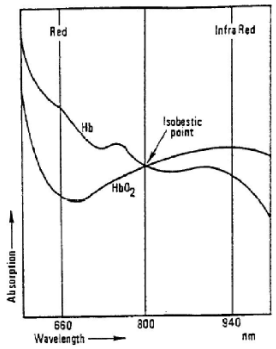

Figure 1. Spectra Absorption Hb and HbO_2 [6]

LEDs are used as light sources and pulsed sequentially at a quick rate. During heart rate, increase blood volume and the AC component of the light sensor which is used today to calculate the absorption of oxy and deoxy-hemoglobin. These waves are obtained from two frequencies beams, in this case the infrared and red light. To get a saturated pulse oximeter (SpO2), AC and DC components of each of these wavelengths need to be measured and taken as a ratio as follows:

$$R = [AC\lambda1 / DC\lambda1] / [AC\lambda2 / DC\lambda2] \quad [1]$$

This ratio is used in the calibration curve based on studies of healthy individuals with the condition to determine the SpO_2. This value will end up being a percentage that will tell if everything is as it should be or not. The normal saturation level is between 87-97%. SpO_2 measurement methods have been proven to be accurate to 2.5%.

RESEARCH METHODOLOGY

In the photopletysmography technique, our prototype used mode of transmission. The mode of transmission is a light source (LED) mounted face to face with a light sensor (LDR) as shown in Figure 2. LDR detect changes in the light emitted by the LEDs due to absorption by organs (blood, skin, and meat / muscle) directly.

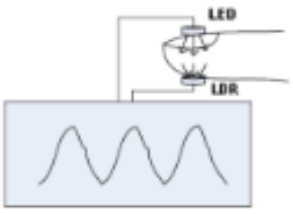

Figure 2. Mode of Transmission

By using a pulse oximetry, which is composed of an infrared LED, red LED, and photoresistor / photo transistor, PPG can be used to measure the oxygen saturation in the blood. Hemoglobin that contains a lot of oxygen (oxygenated hemoglobin) absorbs more infrared light than red light. While hemoglobin-containing less oxygen (deoxygenated hemoglobin) absorbs more red light than infrared light as shown in Figure 3.

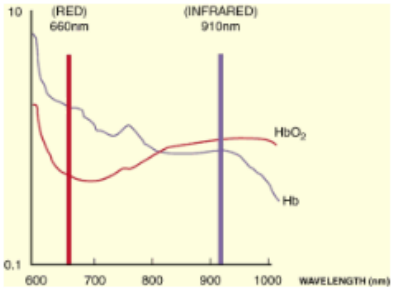

Figure 3. Absorption Red Light and Infrared

RESULT AND DISCUSSION

For preliminary result, prototype of mounted sensor at finger using LED has succeded build. The selection of sensor component such as based on research methodology in the previous section.

Prototype of Mounted Sensor at Finger Using LED

The sensor has been tested and verified. The result is the prototype of mounted sensor has a similar result with off-the-shelf pulse oximetry.

CONCLUSIONS

The mounted sensor using LED as part of ubiquitous Pulse Oximetry has been built. This prototype need more develop to ensure meet the aim of research.

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