International Journal of Emerging Technology and Innovative Engineering
Volume 4, Issue 3, March 2018 (ISSN: 2394 – 6598)

Paper Received on: 16.03.2018
Paper Published on: 21.03.2018

AN OPTICAL DEVICE TO MEASURE BLOOD COMPONENTS BY A PHOTOPLETHYSMOGRAPHIC METHOD

Swetha Saravanan
saran2205@gmail.com

ABSTRACT

The development of the photometric device is based on the realization of a photoplethysmographic device. The non-invasive multi-spectral method is based on the radiation of monochromatic light, emitted by laser diodes in range of 600-1400 nm, through an area of skin on the finger. After interaction with the tissue the transmitted light is detected non-invasively by photo-diodes. The method makes use of intensity fluctuations by the pulse wave. The ratio between the peak to peak pulse amplitudes measured at different wavelengths. The computed coefficients are used for the measurement and calculation of the arterial oxygenic saturation.

Keywords- Non-invasive, photoplethysmography, photometric device.

INTRODUCTION

The absorption of the whole blood in the visible and near-infrared range is dominated by the different hemoglobin derivatives and the blood plasma that consists mainly of water. It is well known that pulsatile changes of blood volume in tissue can be observed by measuring the transmission or the reflection of light. The diagnostic method is called photoplethysmography.

The separation between arterial blood absorption and background absorption can be obtained by evaluating the relationship between the pulse signal components. The DC component is calculated by subtraction of the AC component from the whole PPG signal. The pulsatile change of blood volume is caused by the heartbeat.

Besides, the measurement of oxidized and reduced haemoglobin for the calculation of

oxygen saturation in the arterial blood , the haematocrit value as well as the haemoglobin concentration are also important medical parameters.

The haematocrit absorption and scattering is influenced mainly by the total haemoglobin concentration. The phase-function describes the probability of scattering for a photon travelling in direction to be refracted in direction.

MEASUREMENT METHOD

The optical parameters of blood and its components depend on many factors , such as the haemocrit value ,the oxygen saturation, the flow-velocity, the osmolarity and haemolysis.

The objective of the components of the photometric device (PMD) described here is the non-invasive continuous measurement of light-absorbent blood components in the arterial blood of human finger. This non-invasive multi-spectral measurement emitted by laser diodes in the range of 600-1500nm.

The method takes place as an advantage of the intensity fluctuations caused by the pulse wave. The ratio of the the relative changes of the pulse wave. The ratio of the relative changes of the pulse sizes, when measured at different wavelengths absorbance characterisitics of blood components.

After the interaction with the tissue the transmitted light is detected non-invasively by photo-diodes. The absorption spectra for the main blood components and the system are the five laser diodes of the PMD. Suitable wavelength were selected for the analysis for concentration change.

The measurement method evaluates the waveform of peaks, troughs, DC averages and pulsatile averages. For the calculation of haemoglobin , the wave length are chosen to suit the absorbance peaks of water in blood.

To find a value corresponding to an isobestic point for absorbance of oxyhaemoglobin a wavelength of 808nm is chosen. A second relationship for the measurement and correction of oxygen saturation is greatly exceeds the absorbance of deoxyhaemoglobin transmission signals.

PHOTOMETRIC MEASUREMENT DEVICE

Inside the measurement device the laser diodes are integrated together with the requires control electronics. The device electronics consists of the components required for signal amplification, digitalization and triggering of laser diodes.

The sample frequency of the system is about 7 kHz. After the software mean value calculations and subtraction of the dark-current inside the main unit, the transfer of the photocurrents is achieved with a sample rate of about 100Hz each.

A main component of the measurement device is a high performance DSP system with the floating-point processor. This enables DSP software- control and time-multiplexed operation of five laser and control of each receives channels.

The evaluation of the data and the operation of mathematical algorithm for pre-processing programs. The laser light is transmitted to a special optical transmission head by means of optical fibers inside the sensor probe.

Two photo-detectors D1 and D2 are also contained in the sensor head together with required pre-amplifiers the sensor detected

signals will be processed inside the measurement device.

To detect the transmission signals of lasers (silicon avalanche) is used with spectral sensitivity of 400-1150nm. For detection of the 1310nm transmission signal is required with a spectral sensitivity of 1000-1700nm.

APPLICATIONS AND RESULTS

Previous measurements of the transmission signals of the five wavelengths had shown an apparent variation of the arterial pulse. The signal quality was sufficient to analyze the signal components and to calculate the relative attenuation coefficients of the arterial blood. With regard to the components at 1310nm an evaluation of the relative portions of haemoglobin and water in the blood is feasible.

The measurements technique requires a pulse signal for the vasoconstriction at the extremities can be a problem, as it decreases the signal amplitude and therefore the signal to noise ratio.

A small signal amplitude tends to give inaccurate results. The PMD has, therefore a minimum signal amplitude below which no value for the calculated coefficient is displayed. The lower limit for the pulse amplitude with the 1310nm laser.

The measurements were performed with a person lying calmly in a horizontal position at room temperature. The transmission values of the pulse waves processed are constant with breadth-dependent periodical oscillations for all laser wavelengths.

The PMD is suitable for non-invasive continuous on-line monitoring of one or more biologic constituent values. The objective of this measurement is to reduce the dependence on measurement techniques which requires in vitro analysis.

The patient is also exposed to the normal risks of infection associated with such invasive methods. The non-invasive measurement method described in this paper might be applicable for clinical applications where it can be monitored.