Asian Journal of Information Technology 15 (21): 4299-4301, 2016
ISSN: 1682-3915

Determination of Blood Constituents Using Laser Based Systems

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Abstract: Diseases can be diagnosed from the blood flow through blood constituents which are oriented in the direction of blood flow. In conventional methods, skin texture is pricked for the collection of blood samples which is known as invasive technique. It may lead to damages in the skin texture and intrusion of foreign particles in our body, wastage of blood, painfulness and discomfort to the patients. It requires the assistance of skilled persons to carry out the process of determination. To overcome these problems, non-invasive technique is employed. One of the non-invasive techniques used here is laser based system. In the present study, the laser beam is guided to the index finger as a source of target. The scattered laser beams are collected by the fibre optics which is circumferentially arranged along with transmission fibre to the photo detector. The scattered light is converted into its corresponding electrical voltages. The collected signals are correlated with the blood constituents collected invasively at the time of signal acquisition. The data collection analysis and further processing are done by using Cortex-M4 processer and MATLAB. Simulation results demonstrate that blood constituents in the blood flow with respect to the acquired signals are significantly closer to the calculated value.

Key words: Blood cells, hemoglobin, laser, ARM Cortex, processer and vessels

INTRODUCTION

Human body consists of many systems such as respiratory, circulatory (Cantor *et al*., 1998), nervous, skeletal, muscular and so on (Karpienko *et al*., 2016). Blood plays an important role in functioning of the systems present in the human body and in maintaining homeostasis.

It contains Red Blood Cells (RBC), White Blood cells (WBC), platelets and other micro blood constituents (Isosu *et al*., 2013). It performs many functions such as supply of oxygen (Goldman and Popel, 2000) and removal of waste products (Breepoel *et al*., 1981), transportation of hormones and the signalling of damages in tissue. An average adult has the blood volume of roughly 5 L. Blood regulates pH (Castillo *et al*., 2011) and body temperature and maintains the water content of tissues. Measurement of blood flow and changes in blood volume are of vital importance and provides essential information for the diagnosis of diseases with impaired blood flow (Forbes *et al*., 1991). The measurements of blood flow and its related parameters have been evolved through a number of techniques with different principles. Traditional methods are invasive in nature. They include pricking of blood vessels involve a lot of constraint. To overcome such kind of difficulties, non-invasive techniques are employed for the determination of blood constituents. By using laser based system it is possible to calculate the content of oxygen in the blood and perfusion index. With the help of these values, the amount of Hemoglobin, Red Blood Corpuscles (RBC) cells and so on is possible to calculate from our blood flow stream.

METERIALS AND METHODS

The laser beam is directed to the index finger as source of target via 1000 μ multi mode plastic fibre cable placed circumferentially to the transmitted fibre. The system is based on non-invasive optical structure with red coloured 632.8 nm wavelength 5 mW power He-Ne laser as source (Aryeh *et al*., 2008). Figure 1 gives a detail flow diagram of laser based system.

The photo detectors receive non-absorbed light from the Index finger. The received signal comprises of AC and DC. The DC component represents the light scattered from of the tissue, venous blood and non-pulsatile arterial blood. The AC component represents the pulsatile arterial blood. The obtained signal is given to the filter and amplification circuit. The main objective of the filter is to remove the noise. The amplified signal is then processed in ARM cortex processor. The ARM Cortex-M4 processor with FPU is the latest generation of ARM

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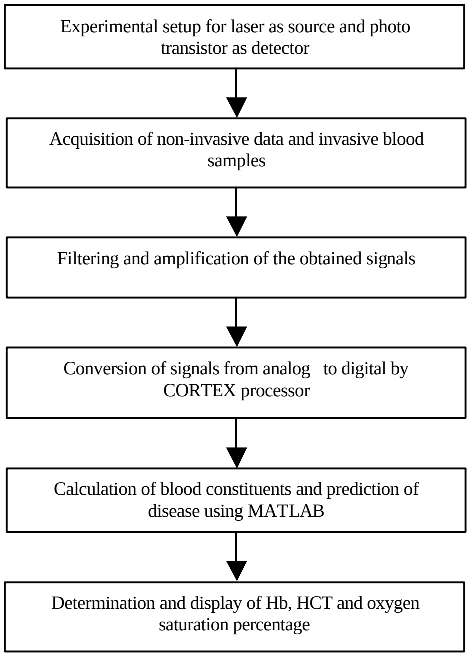

Fig. 1: Flow diagram of laser based system

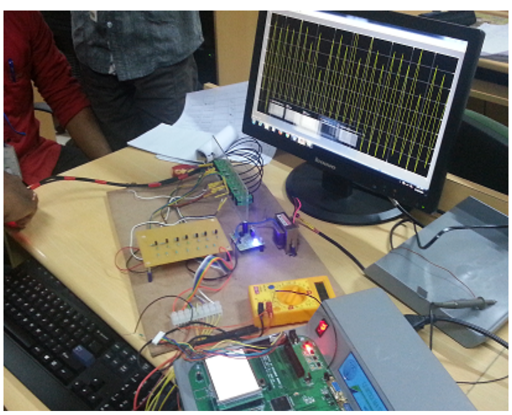

Fig. 2: Experimental setup

processors for embedded systems. It consists of five 12 bit A/D converters as in-built in the cortex M4. Continuous-time and continuous-amplitude analog signal is converted into a discrete-time and discrete-amplitude digital signal using A/D. The signals are manipulated by the algorithm to determine the RBC, Hb and HCT. The resultant values of RBC, Hb and HCT are displayed in LCD display. Figure 2 shows the whole experimental setup.

The whole experimental setup consists of ARM CORTEX M4 processor kit, noninvasive signal acquisition unit and a computer with MATLAB 8.0.

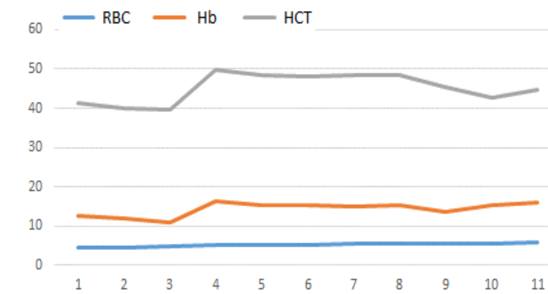

Fig. 3: Relationship of RBC, Hb, HCT

RESULTS AND DISCUSSION

MATLAB is a high performance tool for technical computing. It integrates computation, visualisation and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Y = 475.28X+5E+06. The amount of RBC, Hb and HCT present in the blood stream can calculate with the help of the equation derived from the invasive experimental values. Figure 3 shows the relationship among RBC, Hb and hematocrit cells.

Calculations of parameters: The obtained saturated oxygen content is used to calculate the blood constituents. These constituents are determined with the help of the following formula:

- Total no. of Hb per litre = Total RBC×300 (million per litre)
- No. of Hb carrying oxygen = % of saturated O2×total Hb (million per litre)
- No. of Hb not carrying O2 = Total Hb – No. of Hb carrying oxygen (million per litre)
- Total no. of Hematocrit per litre = Total Hb×300 (million per litre)
- Mean cell volume in femto liters = (Hematocrit×10) / RBC in millions
- Volume of blood flow in litres = Perfusion Index×Blood volume
- Percentage of Oxygen the molecules dissolved = Percentage of oxygen saturated× Constant proportion of oxygen (= 0.0031 mLO_2/mm Hg)
- Mean cell Hemoglobin in picograms = (Hb in gram/dl×10)/RBC in million

CONCLUSION

It can be clearly understood that RBC of a person increases; the number of blood cells also varies according with different permutation and combinations. The increase in the count of RBC will result in the increase in Haemoglobin and Hematocrit (Frasca *et al*., 2014). Thus, the blood constituents such as Haemoglobin that carry oxygen, haemoglobin that does not carry oxygen, RBC count, mean cell volume, percentage of dissolved oxygen in blood, prediction of diseases according to the percentage of oxygen concentration in blood, volume of blood flow and number of Hematocrit cells present in the blood stream can calculate by using the MATLAB tool. With the help of the proposed non-invasive technique, the clinician can easily predict the problem present in the subject or patient without taking the blood from body. This technique is quite feasible to both the clinician and the subject or patient in diagnosis process.

RECOMMENDATIONS

In this present research, non-invasive technique is used to predict some of the constituents present in the blood. It can extend for the prediction the other cells present in the blood such as White Blood Cells (WBC), plasma, platelets, size of the cells, healing applications (Aryeh *et al*., 2008), determination of glucose in image processing (Frasca *et al*., 2014) and so on. By predicting all the remaining cells present in the blood, it is easy to detect the type of disease or disorders present in the subject or patient.

ACKNOWLEDGEMENTS

The researchers wish to thank the Management, Principal, Dean and Head of the Department of Electronics and Communication Engineering, students and Faculty of Kongu Engineering College, Perundurai, Erode for their support to carry out the work successfully.

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