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NON-INVASIVE METHOD OF GLUCOSE AND BLOOD PRESSURE MONITORING USING NIR SENSOR

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Abstract - *Objectives: This paper describes the method of measurement of glucose concentration and blood pressure in the human blood non-invasively using the near infrared optical technique. Methods/Analysis: In recent medical practice, the concentration of glucose in blood and blood pressure is measured using an invasive techniques which generally involves puncturing finger for glucose meaurement and Manual sphygmomanometers are used in conjunction with a stethoscope for Blood pressure measurement. In generic few ml of blood whereas in recent practice less than a drop of blood is taken out and passed through the standard chemical tests to measure glucose concentration. A device used to measure blood pressure, composed of an inflatable cuff to collapse and then release the artery under the cuff in a controlled manner and a mercury or mechanical manometer to measure the blood pressure .Patients should undergo some pain while measuring blood pressure and glucose manually. These methods are expensive as well as painful. The frequent finger puncturing causes calluses on the skin and also increases the risk of spreading infectious diseases. Findings: So, the development of a non-invasive blood glucose and blood pressure measurement system will be boon to the diabetic patients. This paper describes the method of blood glucose and blood pressure measurement in the human blood non-invasively using the painless near infrared based optical technique. The designed system consists of NIR sensor emitting signals in the range of 800nm to 2400nm wavelength. These optical signals are sent through the face and reflected signals are detected by NIR sensor placed beside the arduino. The glucose concentration and blood pressure in the blood is determined by analyzing the variation in the concentration of received signal obtained after reflection using Linear regression algorithm. The results obtained from the designed system shows the feasibility of using NIR based non-invasive method for the measurement of blood glucose and blood pressure. Applications/Improvements: The described system is majorly useful for diabetic patients. The measurement accuracy of the proposed system can be improved by incorporating it with noise filtering techniques.*

Key Words: Non-invasive, blood-glucose, blood pressure, NIR sensor

1. INTRODUCTION

Diabetes is a type of metabolic diseases in which the blood glucose (blood sugar) level and blood pressure in human body increases drastically from its normal level. The increase in sugar level is either due to inadequate production of insulin in blood cells or can be because of improper response of body cells to the insulin or can be because of both the reasons. Diabetes can lead to major complications like heart failure and blindness in the human body .Hence regular monitoring of glucose level and blood pressure is important. In the pathology laboratories, glucose is been measured by puncturing the patient's finger using a lancet to take out a small quantity of blood sample. Inside a glucometer, a series of chemical reactions will take place and as a result of chemical reaction Potassium Ferrocyanide is produced and it reacts with the metals on electrode layer and causes the electric current to flow through the electrodes. More the concentration of glucose in the blood, more the Potassium Ferro cyanide production and more the current through the electrode. This strength of current is used to predict the glucose level present in the blood. Development of a non-invasive glucose and blood pressure measurement technique would be a boom for a diabetic patient. The major advantage of noninvasive measurement methods is the relief from pain and comfort due to no finger puncturing and no cuff usage. The non-invasive methods of glucose and blood pressure monitoring reduces the difficulties involved in glucose and blood pressure measurement and hence reduces the cost of healthcare. The noninvasive method for glucose and blood pressure measurement like IR spectroscopy is popular from years, but method with a reliable results has not been established yet.

The researchers are using various optical methods for the non-invasive measurements which includes near infrared, photo acoustic spectroscopy, Raman's spectroscopy, polarization technique and light scattering techniques. The proposed system consists of appropriate light reflection from human face, optical sensors(NIR), microcontroller and different data processing techniques. Light returned from human tissue is collected by photo-diode through an optical sensor. NIR spectrometry measurement relates to several overlapping bands and so it needs multivariate calibration modelling such as linear regression technique. Hence, data processing techniques combined with the analysis changes in the light intensity permits to extract the chemical components within tissue, i.e glucose and blood pressure. It is observed that by increasing the glucose concentration, the output voltage of the sensor increases in transmittance mode and decreases in reflectance mode. Moreover, for the blood pressure the output voltage of sensor decreases in transmittance mode and increases in reflectance mode.. This paper is all about the measurement of blood glucose and blood pressure non-invasively by using NIR optical

technique which overcomes the problems in invasive measurement like finger puncturing, risk of infection, etc.

The full paper is organized as follows: Section II describes the related work behind the blood glucose and blood pressure measurement, Section III deals with the system practicability. Section IV shows the experimental results of the designed system and Section V concludes the paper.

2. RELATED WORK

Bio impedance is a measure of the resistance to electric current flowing through the tissues of a living organism. The measurement of bio electrical impedance has proved useful as a noninvasive method for measuring body composition. The impedance spectrum, or dielectric spectrum, is measured in the frequency range of 0.1 to 100 MHz. According to Hillier et al., variations in plasma glucose concentration induce, in red blood cells, a decrease in sodium ion concentration and an increase in potassium ion concentration. These variations cause changes in the membrane potential of red blood cells, which can be estimated by determining the permittivity and conductivity of the cell membrane through the dielectric spectrum. In 2003, the company Pendragon Medical Ltd. (Zurich, Switzerland) developed a wrist-band-based glucose monitor called âCœPendra.âC However, this product was soon withdrawn from the market because of poor reliability. Caduff et al are still working on this technology.

Similar to bio impedance spectroscopy, ElectroMagnetic Sensing technology assesses dielectric parameters of blood. The difference between them is that an electric current is used in bio impedance spectroscopy, while the electromagnetic coupling between two inductors is used in electromagnetic sensing. The sensor uses electric currents to detect variation of the dielectric parameters of the blood, which may be caused by glucose concentration changes. The frequency range used in this technique is 2.4âC“2.9 MHz. However, depending on the temperature of the investigated medium, there is an optimal frequency, where sensitivity to glucose changes reaches its maximum. Determining this frequency is important for the efficacy of the device. Gourzi et al. suggested the optimal frequency is 2.664 MHz at 24Â◦C. However, another study of this technology, using pig blood, suggests that the optimal operating frequency is 7.77 GHz at 25Â◦C.

3. SYSTEM PRACTICABILITY

This Project aims to serve the people who are suffering from diabetes. From this project we measure the change in light intensity when a light beam with 750âC“2500nm wavelength is transmitted and reflected. Based on the reflected signal wavelength the blood glucose level and blood pressure is calculated and a report is generated to send to the designated person who can understand the report without the assistance of the doctor. The project will demonstrate by taking the scattered signal from NIR sensor and the signal processing is done using At mega 328 controllers, the result obtained will be formatted in the form of a message with the help of Arduino IDE which can be integrated with Atmega328. The message generated is sent with the help of GSM module to a specified cell phone number. Near infrared (NIP) spectroscopy is a location in the wavelength range of 730-2500nm. It allows blood pressure measurement in tissues by variations of light intensity, based on transmittance and reflectance. The medical application which is proposed now can be viewed through the mobile app about the full history of a patient even by accessing from the remote location. Near Infrared (NIR) spectroscopy to decide blood glucose levels in light of transmittance spectroscopy on the ear flap.

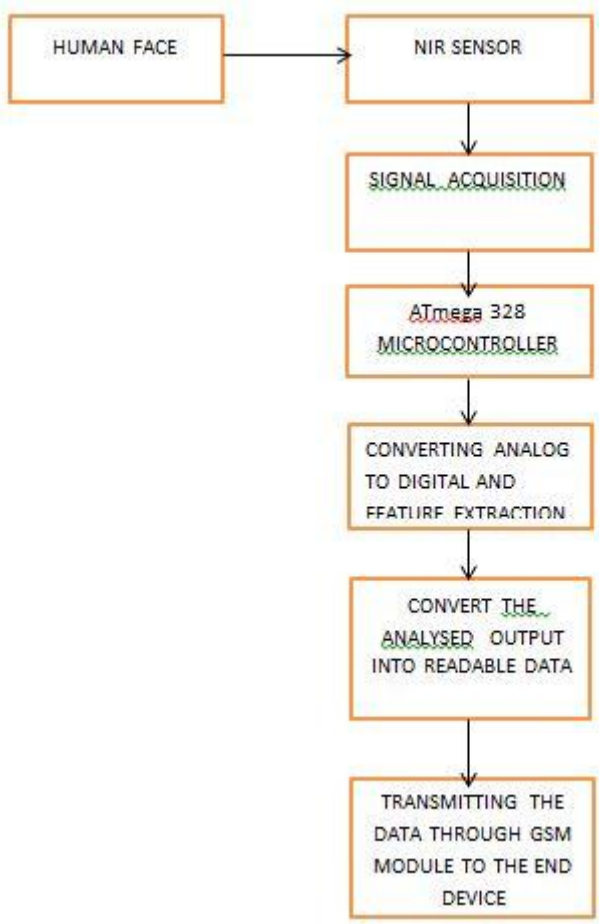

Fig. 1. Block diagram of blood pressure and glucose monitoring using noninvasive method.

4. ARDUINO UNO

Arduino is an open-source hardware and software company, project and user community that designs and manufactures single micro controllers and microcontroller kits for building digital devices and interactive objects that can sense and control both physically and digitally. Arduino board designs use a variety of microprocessors and controllers. The boards are equipped with sets of digital and analog input/output

(I/O) pins that may be interfaced to various expansion boards or breadboards and other circuits. The boards feature serial communications interfaces, including Universal Serial Bus (USB) on some models, which are also used for loading programs from personal computers.

Fig. 2. Arduino UNO

5. NIR SENSOR

Near Infrared (NIR) measurements are based on specific absorption bands in the electromagnetic spectrum between 800 and 2500 nanometers (nm). This region is just above the visible light region of 400 – 700 nm. Electromagnetic waves in the region have the best combination of energy, sensitivity and absorption to be useful for quantitative measurements of solid materials.

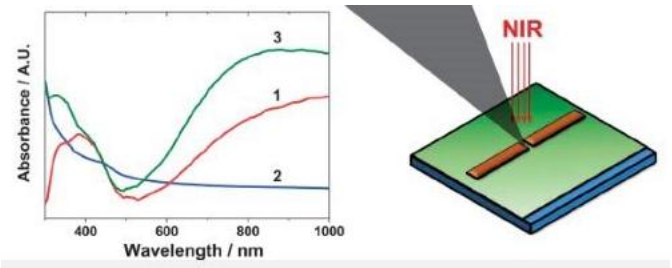

Fig. 3. NIR Sensor.

6. RESULT

The proposed system consists of appropriate light reflection from human eye, optical sensors(NIR), microcontroller and different data processing techniques. Light returned from human tissue is collected by photo-diode through an optical sensor. NIR spectrometry measurement relates to several overlapping bands and so it needs multivariate calibration modelling such as linear regression technique. Hence, data processing techniques combined with the analysis changes in the light intensity permits to extract the chemical components within tissue, i.e glucose and blood pressure. It is observed that by increasing the glucose concentration, the output voltage of the sensor increases in transmittance mode and decreases in reflectance mode. Moreover, for the blood pressure the output voltage of sensor decreases in transmittance mode and increases in reflectance mode

Figure 4: Module of the project.

Figure 5: Glucose concentration being seen in the LCD.

Figure 6: Blood pressure output seen in the LCD.

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