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Designing and Implementation of Non Invasive Blood Glucose and Hemoglobin Detection using NIR

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Abstract— our project describes the tactic of measurement of the glucose concentration and simultaneously hemoglobin within the human blood non-invasively using the painless near infrared-based optical technique. In recent practice, the concentration of glucose and hemoglobin in blood is measured using invasive techniques which generally involve pricking finger (commercial Glucometer and samples using spectroscopy). The frequent finger pricking causes damages on the skin and also increases the danger of spreading infectious diseases. So, the development of non-invasive blood sugar and hemoglobin measurement system are going to be a boon to diabetic patients. The designed system uses Near Infrared (NIR) spectroscopy to work out blood sugar levels supported transmittance spectroscopy emitting signals of 940nm wavelength. These optical signals are sent through the fingertip and reflected signals are detected by phototransistor placed beside. The glucose concentration and therefore the hemoglobin within the blood are determined by analyzing the variation within the intensity of the received signal obtained after reflection. The described system is majorly useful for diabetic patients. In our project, we used Ardunio Uno for the acquisition and processing of the signals. The developed low-cost device could avoid complicated procedures and provides continuous monitoring of glucose and hemoglobin concentration.

Keywords : Acquisition, Ardunio Uno, Continuous monitoring, Diabetic patients, Glucometer, Glucose, Hemoglobin, Non invasive, Near Infrared spectroscopy.

I. INTRODUCTION

Diabetic Mellitus is that the third leading explanation for death in many developed countries. It's a clinical condition characterized by increased blood sugar levels (hyperglycemia) thanks to insufficient or inefficient (incompetent) insulin. A healthy individual has 70 - 100mg/dl blood sugar level during fasting and after ingestion of carbohydrate meal the blood sugar level rises to 120 – 140mg/dl. Diabetic Mellitus is of three types: (I) Insulin-dependent DM, (ii) Non-insulin-dependent DM, (iii) Gestational diabetes. The complication of diabetes affects the attention, kidney and systemanervosum .

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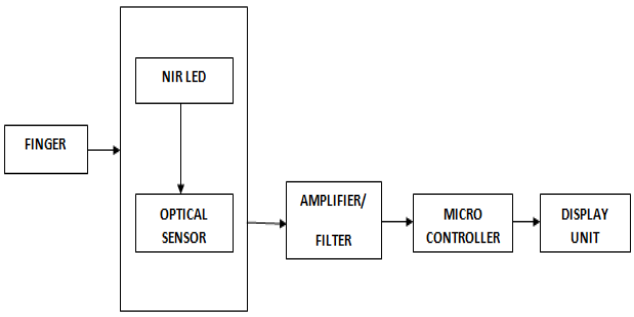
Anemia is caused thanks to the low volume of red blood cells within the body. As per the statistics of WHO about 60% of individuals are suffering from anemia which is predominantly found in children and pregnant women [1], [2], [7]. Anemia may occur along side diabetes because the RBC producing hormone called erythropoietin (EPO) is secreted by the kidney. Changes within the kidneys that occur along side diabetes may cause chronic renal disorder. Early detection and treatment are essential to stop or delay disease progression [5]. Currently, blood sugar and hemoglobin are often monitored by the invasive method that involves the pricking of a finger to draw the blood samples (conventional method). The danger involved in these methods results in infectious inconvenience. So there's a requirement for non-invasive methods to beat these drawbacks. Diabetes results in various organ problems (blindness, renal failure, strokes). It's estimated that the speed are going to be increased by 693 million. There's a requirement for a correct monitoring system for blood sugar level because at the present we've an invasive method to see the blood sugar level which is completed by pricking finger (glucometer which may be a very inconvenient method for blood sugar monitoring)[8],[11],[16].

II. METHODOLOGY

The diagram shown below gives a quick description of the working method involved in our Project. We are getting to combine the blood sugar and hemoglobin monitoring system non-invasively using near IR spectroscopy which is supported transmittance [9], [14].
Our proposed module has the following three units: (i) Sensing unit, (ii) Processing unit, (iii) Display unit.



The initial problem was the utilization of invasive and minimally invasive methods for blood sugar concentration measurements.

To deal with this problem, this project observed uses near-infrared as a possible means to live blood sugar and Hb levels which will be a non-invasive monitoring.
To implement the near- infrared spectroscopy, a LED that emits light at 940 nm was chosen and used. To detect the reflected light, a photodiode with an electromagnetic sensitivity to electromagnetic light between wavelengths of 1000nm to 870nm was used. A reflective optical sensor serves this purpose well and it reduces the losses that occur while constructing an LED- Photodiode pair manually. The peak wavelength of glucose is 920nm approximately. The voltage reading from the photodiode is amplified and filtered employing a non-inverting amplifier and is converted into values by the microcontroller and therefore the output is viewed within the display. Using near-infrared light of wavelength 1000nm, minimum photodiode output voltages were an equivalent for all individuals (1.5V). Maximum photodiode output voltages range from 3 to three .8V for the individuals [2], [12],[14],[15].

III. PRINCIPLE OF THE PROPOSED MODEL

When there is high blood stream in the body the blood beats through the finger and the red platelets adjust themselves and as current goes through in such condition, there is in every case less opposition of current. In any case, when there is a lower blood stream the red platelets skew themselves. They tend to clusters together and get hard for current to go through easily. Subsequently the protection from flow in blood stream decides electrical impedance of the laser in close to infrared range to the skin (finger) which identify with the intensity of blood glucose. More elevated levels of blood glucose would bring about more noteworthy misalignment or clustering of the red platelets and there will be a higher resistivity.[2],[14]

A. NIR light source- TSAL6100

The NIR LED utilized in the system is TSAL 6100 with a wavelength of 940nm.This LED has an emitting angle and therefore the power that suitable for the system, and that results in a decrease of scattering light. A continuing current circuit is meant for the emission of NIR to attenuate the fluctuation within the current through the NIR LED. Because the current flows, electrons fall from one a part of the diode into another part. To fall under these holes, the electrons shed the energy within the sort of photons, which produce light [3], [4].

B. Optical sensor-OPT101

The main function of an optical sensor is to convert light rays into electronic signals. In our project, the purpose of this sensor is to provide higher and classified accuracy for two different parameters (glucose and hemoglobin concentration).And also OPT101 is highly sensitivity enough thus it might not be affected an excessive amount of by another light from the environment or scattering light. And it also doesn't produce any irritation to patients [3], [5].

C. Microcontroller

In our proposed model we used Arduino Uno, a microcontroller board supported the ATmega328 (datasheet). It consists of 14 digital input/output. It is very cost efficient and also simple to use in urge. Its input voltage is going to be 7-12V which can be run with the support of 9 V batteries itself. It's non-volatile storage 32kb [5], [10], [12]

IV. WORKING MODEL

The sensing unit comprises of NIR light TSAL6100, which is that, the main part of the proposed module. This led has decreased scattering light which provides an effective emitting angle and power for the system. It also withstands current fluctuations and an op-amp LM358 plays a task as a current stabilizer [3]. As soon as the index of the patient is kept on the sensor it'll sense the hemoglobin and blood sugar level through the blood sugar sensor and hemoglobin sensor [11]. The height wavelength of those glucose and hemoglobin reflective sensors is 940nm and 870 mm approximately. The so obtained signals will be sent for the amplification and filtration process. In our project we are using Arduino Uno may be a microcontroller board supported the ATmega328, it's lower power modes 14ADC channels and calibrated internal oscillator. And it also has extra features when compared with others. It's also cost-efficient. Finally, the output is going to be displayed in LCD as blood sugar level and hemoglobin level separately [15], [16].

V. SOFTWARE REQUIREMENTS

- Arduino IDE
- Embedded C Programming

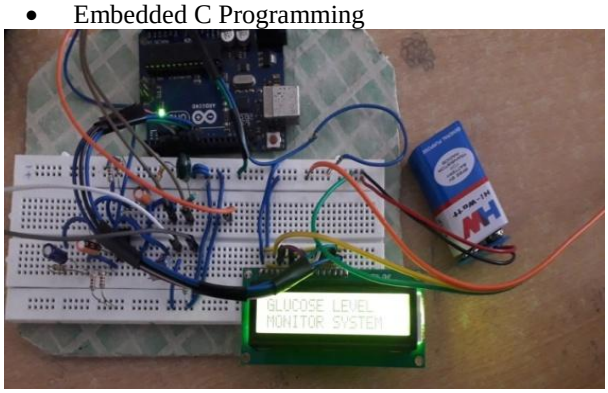


Fig.1 Displaying the glucose monitoring project module

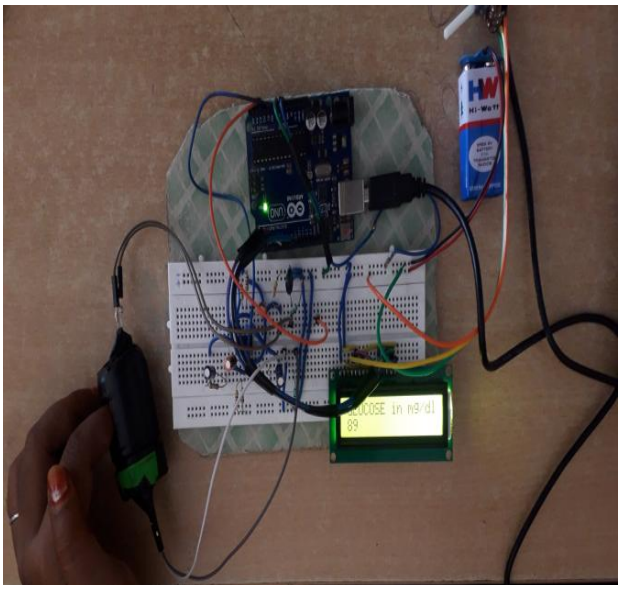


Fig. 2Model displaying the glucose value in LCD (mg/dl)

VI. RESULT AND DISCUSSION

We have conducted the test with the some normal volunteers and acquired the glucose concentration in mg/dl. Theparameter observed more or less meet the accuracy of the same parameters obtained through the invasive method. The following tabulation is the results obtained from our non invasive glucose monitor

SUBJECT	GENDER	AGE	GLUCOSE LEVEL IN (mg/dl)
1	Female	21	120
2	Male	20	82
3	Female	22	89
4	Female	21	89.5
5	Male	21	125

VII. CONCULSION

Last, this project has suggested a way for non-invasive blood sugar testing. With the implementation of NIR-occlusion spectroscopy at a wavelength of 940 nm.Although not as accurate as present-day invasive or minimally invasive techniques for measuring blood sugar concentrations, but the utilization of near-infrared light provides a way of non-invasive measurement with less pain and discomfort to the diabetic patients and improve the standard of their lives through effective diabetes management. Thus far we've made our model with non-invasive blood sugar detection using NIR which can be further developed and extended. The existing methods of glucose monitoring are mostly invasive and not affordable. Extracting of blood is needed for the determination of glucose level and hemoglobin content which is very inconvenient to the patients. And Invasive method can cause irritation and infection to the patient. All these drawbacks will be overcome by our proposed method.[7],[9],[11]

FUTURE WORKS

We are getting to implement a hemoglobin detection system along with this proposed model where OPT101 will be added for more accuracy[6] .After further developments it can be used as a portable and wearable device as per the patients convenience for continuous glucose and hemoglobin monitoring using IOT. This will be easy for the patient to record and send the acquired data to their doctor and caretakers without any difficulties. [13], [15], [16].

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