NOVEL APPROACH TO NON-INVASIVE BLOOD GLUCOSE MONITORING BASED TRANSMITTANCE AND REFRACTION OF VISIBLE LASER LIGHT

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***Abstract*: Smart Device is proposed to monitor the Blood Glucose of a person without harming. The Laser and photo diode is used to sense the Glucose level of the patient by the IR transmitter and the IR receiver. It senses the blood glucose level every 7 seconds. The Smart Device for glucose monitoring is mainly based on Laser and photo diode, Arduino UNO, Arduino IDE, LCD, Cloud and Mobile Application. The result will be displayed in the LCD and mobile application and the device can be used at any time and at any place using Internet.**

***Keywords*: Diabetes Mellitus, Glucose, Blood pricking, Cloud, Chronic disease, Laser and photo diode, Arduino UNO, Arduino IDE, LCD, Mobile application.**

1. INTRODUCTION

Diabetes is major challenge of this current decade. It is a non-communicable disease. As per report by the Indian Diabetic Association, about 63 million people suffer from diabetes, and this is likely to go up to 80 million by 2025.Diabetes people check blood glucose level more than two times per day. Hence they are inconvenienced every time. They are suffering from the danger of infection by pricking blood in the finger. Also this method may expenses associated with strips and Lancets are more because each test requires a new test-strip and Lancets. Diabetes Mellitus is considered as one of the major death contributors in non-contagious diseases. The current method uses the self-monitoring glucose meter. These methods are invasive. The disadvantage this method is that, extracting the blood from the body and doing chemical analysis. It also gives pain and discomfort due to the frequent finger pricks to the patients. Non-invasive techniques are more useful and user friendly. It reduces the costs and other difficulty includes both mental and physical pain which involved in invasive method of glucose determination. Researchers are still not able to overcome many drawbacks of invasive glucose monitoring method. The problem includes the scanning pressure that must be applied, physiological differences such as width of tissues, correlation error, hardware sensitivity and stability [2]. The proposed technique uses a near infrared sensor for transmission and reception of rays from forearm. By analyzing the intensity variation in received signal by using photo- detector at another side, level of glucose can be predicted. Then the data can be transmitted to remote android device for further analysis. An easy and pain- free method of measuring blood glucose concentrations will give the information to the doctors and patients by monitoring the glucose level.

2. LITERATURE REVIEW

Monitoring of glucose level of blood is important to avoid complications of diabetic and damage to organs. Since invasive method of glucose level measurement is painful and causes damage to nerves, non-invasive method is used as an alternative. Shinde and Prasad [1] described a noninvasive glucose monitoring method in which the NIR is sent through the fingertip and over-systolic pressure is applied to the finger to stop the flow of blood for a period of 30 seconds. The response of the optical signal thus obtained is studied by performing the FFT analysis using the spectrum analyzer. Chi Fuk So at.el [2] reviewed recent advances in noninvasive glucose monitoring and concluded that optical method is one of the painless and promising methods that can be used for noninvasive blood glucose measurement. Jyoti Yadav [3] used NIR LED of 940nm wavelength to analyze the glucose concentration by conducting experiment on the human forearm. The noninvasive blood glucometer design containing two LEDs of the same wavelength with one acting as photo emitter and the other as the photodetector is proposed in [4]. In [5] a total of 8 LED pairs were tested for sensitivity to different glucose concentration and it is reported that among all the LED pairs tested, the most effective pair was NIR LED with the wavelength of 1450 nm. Three different probes (arm, finger, ear lobe) were designed to measure blood glucose using 940 nm NIR LED. Parag et.al [6] placed emitter and detector on the same side of the finger to detect the reflected signals properly, hence a phase shift of 180˚ occurs between transmitted and reflected signals.

3. EXPERIMENTAL METHOD

To develop a non-invasive method for measuring blood glucose concentration levels. Such a method would be pain-free and therefore possibly more desirable amongst a larger population for use with continuous health monitoring. The solution would be using near-infrared light to measure blood glucose concentration levels [5]. Hence it would not require tedious amounts of test strips for each measurement. It may be easily recommended and used by the common people to monitor their day-to-day health.

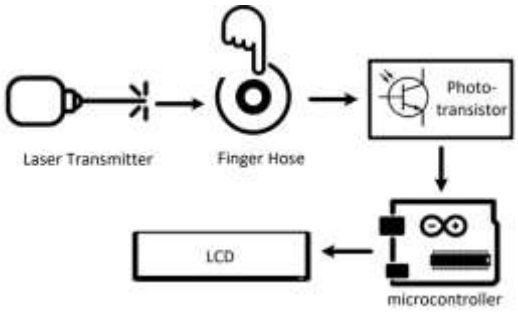

Figure 1: proposed system

2.1. Hardware's

2.1.1. Laser and photo diode

Sensors are the electric device which is used to sense the changes that occur in the body and in the environment. The change includes the pigmentation colour, temperature, humidity, sound etc. They sense the changes that occurred and notify accordingly. In Laser and photo diode, there is an emitter and detector. Emitter emits the laser rays and detector detects it [5].

2.1.2. Arduino UNO

The Arduino UNO is open source software and hardware development environments which contain the ATMEGA328. The embedded C code is inserted into the Arduino UNO using port connection.

2.1.3. LCD

LCD stands for Liquid Crystal Display. It is a small thin, flat panel (normally 16*2) used for electronically displaying information.

Figure 2: LCD Display

2.1.4. Power supply

A rectifier's job is to convert an Alternating Current (AC) to Direct Current (DC) and gives the desired output. Rectifiers are used in the power supplies to provide necessary DC voltage for the electric components or the devices. They are made with four or more diodes or other controlled solid switches. The below diagram describes the working function of the rectifier when connected to power supply.

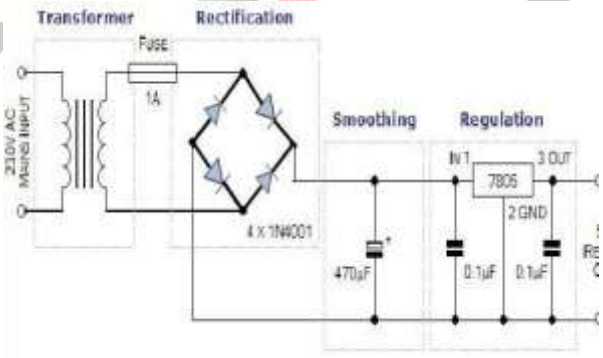

Figure 3: Power supply module

1. **2.2. Software's**

1) **Arduino IDE**

The Arduino IDE is an open source hardware design and software SDK. It functions similarly to the Arduino UNO.

3. METHODOLOGY

When the supply is given to Laser and photo diode via the transformer, resistor, capacitor and diodes, the LED starts emitting light radiations. If the surface is of white colour then it reflects all the radiations. The white surface reflects all the radiations falls on it whereas the black colour absorbs them. As these radiations starts falling on the photodiode which is connected in reverse bias, the resistance of the photodiode starts decreasing rapidly and the voltage drop across the diode also decreases. The voltage at Pin 3 starts increases, as it reaches just beyond the voltage of Pin 2 the comparator gives high output. In the black surface, even though

the LED emits light but it is not reflected, hence the photodiode doesn"t detects anything and its resistance will be infinity. So the comparator will give the low output. Here for every seven seconds the Laser and photo diode emits the light and the readings are calculated and displayed in both LCD and Mobile Applications. The diagram shows the working strategy of Laser and photo diode and Photo diode.

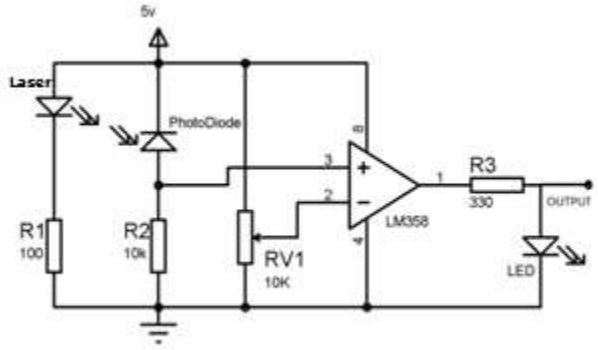

Figure 4: Laser Working principal

4. RESULT AND DISCUSSION

The desired prototype system is designed and developed for the detection of blood glucose level using Non-invasive IR technique. The result was approximate when compared with pricking methodology.

5. OUTPUT

Figure 5: LCD Output

Figure 6: Hardware output

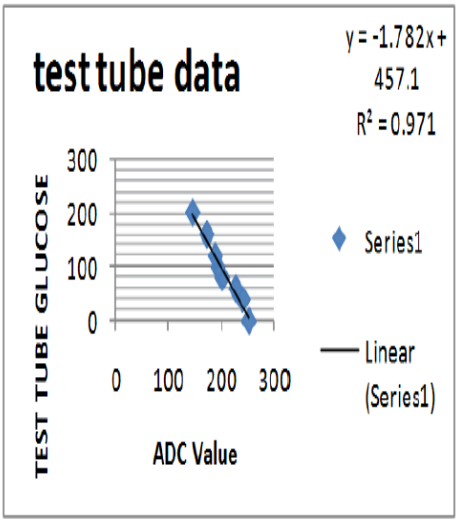

Figure 7. A Graph Of known glucose concentration against ADC values

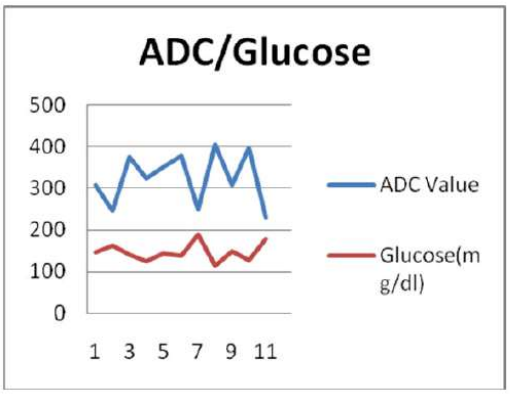

Figure 8. A Graph of ADC Values verse Glucose (mg/dl) Values

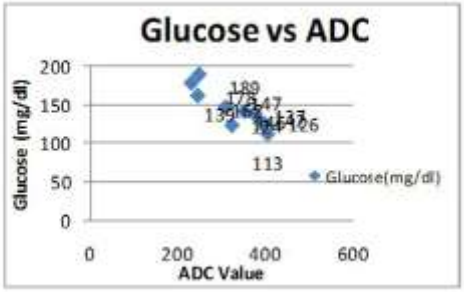

Figure 9. Non Invasive Verse Invasive Values Plotted Graph

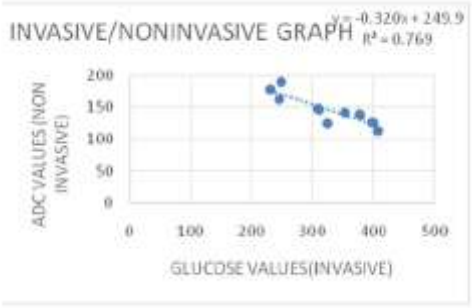

Figure 10. Invasive /noninvasive graph

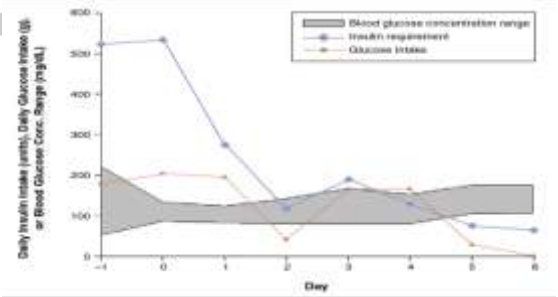

Figure 11. Summary of insulin and glucose intake and blood glucose concentrations

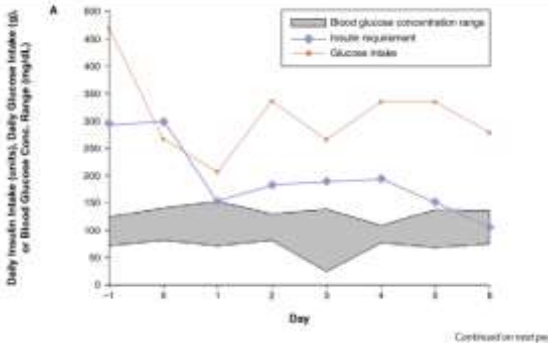

Figure 12. Summary of insulin and glucose intake and blood glucose concentrations

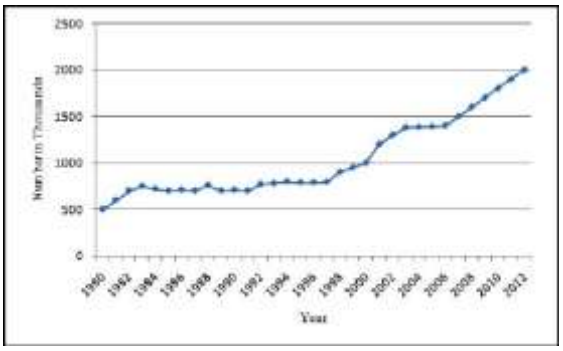

Figure 13. Statistical Analysis of Diabetic Patients

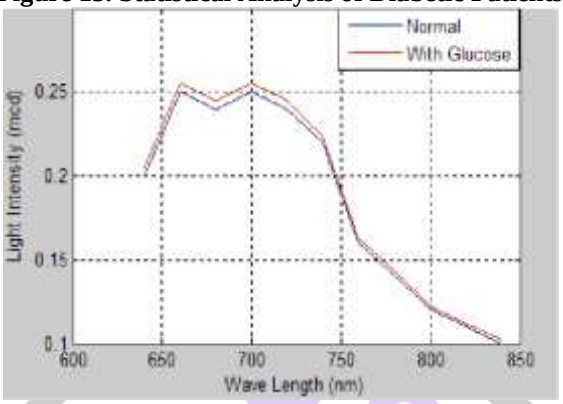

Figure 14. Variation in light intensity with glucose concentration

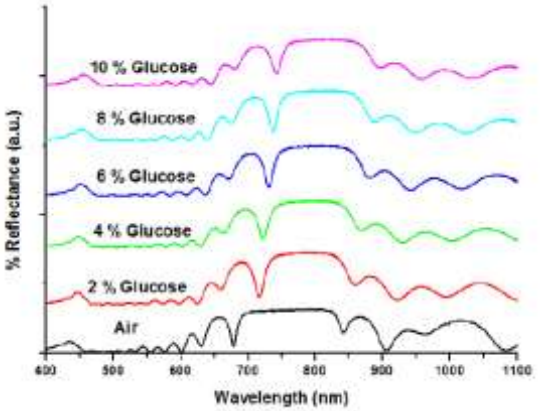

Figure 16. Wavelength Shift in the Reflectance Spectra of sensor device before and after glucose Adsorption.

Table 1 : analysis person 1 (Muthu)

Testing condition	Normal system	Our system
6 AM	125	120
10AM	200	210
12PM	220	218
3PM	210	208
6PM	198	165
10PM	188	185

Table 1 : analysis person 2 (Sham)

Testing condition	Normal system	Our system
6 AM	150	154
10AM	165	168
12PM	180	175
3PM	195	179
6PM	187	188
10PM	210	207

6. CONCLUSION

Early detection of glucose level and control of disease is necessary. Our approach for monitoring glucose level is healthier than the invasive approach. The obtained result shows the glucose level in blood by non invasive method. Glucose level is analyzed and results were obtained approximately. Also this information can be sent to doctor for the further analysis.

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