Non-Invasive Measurement of Glucose from Saliva

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Abstract- *Diabetes prevalence is increasing rapidly over years.The increase in the prevalence in developing countries follows the trend of urbanization and lifestyle changes. A non-invasive method which replaces the older method of usage of blood can improve the diagnosis of glucose levels while reducing pain and complexity of testing. The correlation between the blood and saliva glucose levels helps in designing a non-invasive biosensor for diabetes test. This method provides a digital reading of the patients glucose level in lesser time and is also economical to use. The readings are sent via a Bluetooth module to the mobile for further analysis and storage of results. Thus an alternative setup which uses saliva for on time diagnosis and continuous management of diabetes can be designed.*

I. INTRODUCTION

Diabetes mellitus is a medical condition in which the body does not adequately produce the quantity or quality of insulin needed to maintain a normal glucose level in blood.Two types of diabetes are common. Type-I is also known as Insulin Dependent Diabetes Mellitus which lacks the insulin production needed by the body to maintain the normal blood glucose. Type - II or Non-Insulin Dependent Diabetes Mellitus in which the body cannot use the produced insulin. Frequent self-monitoring of blood glucose is for effective treatment and reduction of the morbidity and mortality of diabetes. In the past few decades there has been an increased urge for a compact and convenient non-invasive device which can frequently test glucose that helps in control of blood glucose levels. Unmonitored diabetes can lead to several secondary complications like kidney failure, heart failure and blindness. Therefore an non invasive method of continuous monitoring of glucose levels may help reduce the complications. In present day, the glucometer device which takes a drop of blood sample as input is used for testing the glucose level. But this method is being painful and invasive . This paper discusses non invasive technique that can be opted for the testing of diabetes using saliva.

The content of this paper is structured as followed.The Existing system in section 2. The hardware and software setup and description is given in section 3.The work flow of the project is described in section 4.Section 5 is the results and discussion along with the validation.The last section 5 is the conclusion along with future works.

II. EXISTING SYSTEM

There are two methods of detection of blood glucose level. They are 1) Invasive 2) Non invasive Invasive method involves the use of blood glucose strips which is made up of plastic. The tip of the finger is pricked by using this and the quantity of blood required for this test is 1l to 2l. The end of the strip with glucose oxidase or glucose dehydrogenase that chemically reacts with glucose in the blood and converts into voltage by analog to digital convertor. With the help of C programming the microcontroller drives the LCD which displays the glucose level. This method is pain and cause discomfort to the patient for every time. To avoid such painful process non-invasive techniques were developed.Non-invasive system includes many methods. They are NIR spectroscopy, Raman spectroscopy, electrical impedance, etc,. In NIR spectroscopy the near infrared light at a wavelength of 7502500nm is passed through blood. The molecular formula for glucose is C6H12O6 which consists of C-H, O-H &C=O bonds. This causes the absorption of NIR light in blood. Then the IR detector detects the amount of IR light. The Beer Lambert's law allows the calculation of absorption of a sample from the concentration and thickness. The sensor output is collected and converted into voltage by analog to digital convertors. In Raman spectroscopy, the laser light is transmitted through a fibre optic cable to the optical probe, which contains an optical filter to select a desired line. After that the Raman Effect occurs when it irradiates the sample. The probe collects the Raman light and transmitted onto a spectrometer where it is split into separate wavelength and detected on CCD camera. These optical methods of detection of blood glucose do not achieve the absolute accuracy. After that breath analysis came into account. The breath analysis involves the use of gas sensor which detects the glucose level in the blood from the exhaled breath. Acetone is one of the volatile organic compound present in the exhaled breath which is the metabolic product of fat burning. For diabetic patients, there is an increased level of acetone in the blood because of the breakdown of excess acetyl-CoA. The breath acetone concentration ranging from 1.7ppm to 3.1ppm can be detected in diabetic patients. For healthy patients it ranges between

0.3ppm and 0.9ppm. Here TGS (SnO2) sensor is used as an acetone sensor. The resistance of this sensor varies depends on the concentration of the acetone present and can be detected by potential divider circuit. They used the Artificial Neural Network (ANN) to calculate the blood glucose level.

III. PROPOSED METHOD

1. Hardware setup

A.Sensor

The heart of this project is the light sensor TCS3200-DB.It is a complete color detector, including a TAOS TCS3200 RGB sensor chip, white LEDs, collimator lens, and standoffs to set the optimum sensing distance. The TCS3200 has an array of photodetectors, each with either a red, green, or blue filter, or no filter (clear). The filters of each color are distributed evenly throughout the array to eliminate location bias among the colors. Internal to the device is an oscillator which produces a square-wave output whose frequency is proportional to the intensity of the chosen color.The applications of colour sensor are Test strip reading,Sorting by color, Ambient light sensing and calibration,Color matching.

In the TCS3200, the light-to-frequency converter reads an 8 x 8 array of photodiodes. Sixteen photodiodes have blue filters, 16 photodiodes have green filters, 16 photodiodes have red filters, and 16 photodiodes are clear with no filters.When choosing color filter, the TCS3200 can allow only one particular color to get through and prevent other color. For example, when choosing the red filter, only red incident light can get through, blue and green will be prevented.Similarly ,when choose other filters we can get blue or green light.

B.Arduino

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller.The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits.The board features 14 Digital pins and 6 Analog pins.It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It has a flash memory of 32KB and has a reset pin.The sensor datas are given to the controller for processing and the glucose measurement value is viewed through a LCD display module.

C.LCD Display

LCD (Liquid Crystal Display) screen is an electronic display device with wide range of applications. A 16x2 LCD display is beginner level module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs.

D.ZigBee

ZigBee is a wireless technology which provides connection between the devices. It is the only open global standard to fulfill the needs of low cost, low power wireless network used for device monitoring and control. The ZigBee standard is based on IEEE 802.15.4. It depends on power output and environmental factors. It can use long distance communication using intermediate devices. The data is passed through the mesh network of intermediate devices and it reaches the distant devices. The devices are secured by 128 bit symmetric encryption keys. ZigBee also provides long battery life. It is simpler and less expensive than Bluetooth, Wi-Fi etc. Two Zigbee modules are used used for transmitting and receiving of datas from the Arduino.The received datas are further transmitted to be stored in cloud using Node MCU.

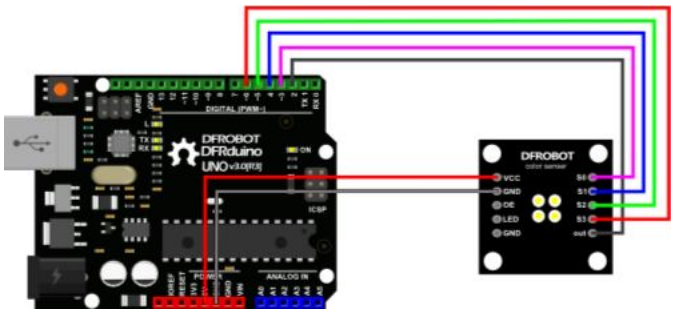

Fig. 2. Connection diagram

2. Software setup

D.Cloud

Cloud storage is a model of data storage in which the digital data is stored in logical pools, the physical storage spans multiple servers (and often locations), and the physical environment is typically owned and managed by a hosting company. These cloud storage providers are responsible for keeping the data available and accessible, and the physical environment protected and running. People and organizations buy or lease storage capacity from the providers to store user, organization, or application data. Cloud storage services may be accessed through a co-located cloud computer service, a web service application programming interface (API) or by applications that utilize the API, such as cloud desktop storage, a cloud storage gateway

or Web-based content management systems.

Thing speak

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates.ThingSpeak was launched by ioBridge in 2010 as a service in support of IoT applications.

E.App

The datas are transmitted into the mobile app using the bluetooth module HC-06. It is a wireless technology standard for exchanging data over short distances (using short-wavelength UHF radio waves in the ISM band from 2.4 to 2.485 GHz) from fixed and mobile devices, and building personal area networks (PANs). Range is approximately 10 Meters (30 feet).It has a flash memory of 8MB for long term storage.These small (3 cm long) modules run on 3.3V power with 3.3V signal levels.The module has two modes of operation, Command Mode where we can send AT commands to it and Data Mode where it transmits and receives data to another bluetooth module.The app called Diabetic care is created using eclipse software to transmit and view the readings from the LCD display.

IV. WORKING

In the process to develop the system, kindly it is divided into several main parts and need crucial designs in each stage.this paper state that,to analyze and predict glucose concentration, it is possible by using light. The proposed system setup consists of a reflective optical sensor, for transmission and reception of light rays with the saliva as the sample for glucose measurement. The proposed system architecture is shown in fig1.The optical sensor used is light sensor.

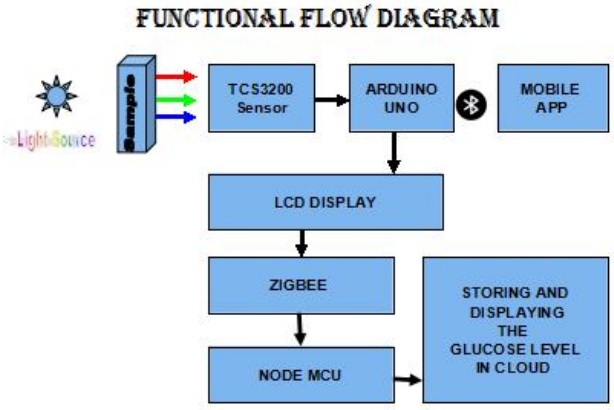

Fig. 1. Complete Block diagram

Light signals are passed through the saliva and detected by sensor. The sensor output get converted into voltage signal by photodiode. The output of the photodiode is filtered and amplified then fed to a microcontroller unit,to perform voltage variation analysis of the received signal, so as to monitor whether the obtained value is within threshold. Here intensity is inversely proportional to voltage. The output will be send to the cloud and it can be seen in the mobile application through wireless transmission. The output can also be seen in the LCD display .

V. RESULTS & DISCUSSION

Our proposed system is tested with several saliva samples and compared with the normal glucometer results

S.no	Actual glucose values (mg/dl)	Standard glucometer value (mg/dl)	Proposed glucometer Value (mg/dl)
1	82	82	80
2	93	92	91
3	95	96.5	93
4	98	97	99
5	103	102	103
6	106	109	104
7	118	117	115
8	127	128	127.5
9	145	145	143
10	185	189	187

VI. CONCLUSION

In this paper we have designed an non-invasive technique to monitor the daily glucose levels of individuals using both the hardware and software systems.This technique will be user friendly, as it portable and gives automatic measurements on giving the saliva samples to it.Our proposed method gives good accuracy which is proved through the laboratory test for measuring glucose level.The datas are stored in cloud and in a mobile application which is a key for continuous and regular monitoring of any individual.After clinical verification, this prototype can be used as a device to eradicate the use of blood for diagnosis of diabetes.

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