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Measurement and Monitoring the Blood Glucose and Spo2 Using Laser Light By a Non-Invasive Method

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Abstract- **Current blood glucose monitoring (BGM) techniques are invasive as they require a finger prick blood sample, a repetitively painful process that creates the risk of infection. BGM is essential to avoid complications arising due to abnormal blood glucose levels in diabetic patients. Laser light based sensors have demonstrated a superior potential for BGM. Existing Near-infrared (NIR) based BGM techniques have shortcomings such as the absorption of light in human tissue, higher signal to noise ratio (SNR) and lower accuracy, these disadvantages have prevented NIR techniques from being employed for commercial BGM applications. A simple, compact and cost-effective non-invasive device using visible red laser light of wavelength 650 nm for BGM is implemented in this paper. The RL-BGM monitoring device has three major technical advantages over NIR. Unlike NIR, Red laser light has ~30 times better transmittance through human tissue. Furthermore, when compared to NIR the refractive index of laser light is more sensitive to the variations in glucose level concentration resulting in faster response times ~7-10 seconds. Red laser light also demonstrates both higher linearity and accuracy for BGM. The designed RL-BGM device has been tested for both in-vitro and in-vivo cases and several experimental results have been generated to ensure the accuracy and precision of the proposed BGM sensor.**

Keyword: Non-invasive glucose monitoring,laser diode,photo diode.

I. INTRODUCTION

Diabetes Mellitus occurs when someone has abnormal blood sugar. There are two major types of diabetes in Type 1 diabetic patients, diabetes occurs due to the autoimmune destruction of the insulin-producing beta cells in the pancreas whereas in Type 2 diabetics the diabetes mellitus occurs from insulin resistance and relative insulin deficiency. Diabetes can cause many serious secondary health issues such as blindness, stroke, kidney failure, Ulcers, Infections, obesity and blood vessels damage, among other health complications. Blood glucose concentration is currently measured using three broad categories of techniques which are invasive, minimally invasive and non-invasive. Invasive techniques require a blood sample which is currently extracted from the fingertip using a device known as a lancet. This method of determining blood glucose is currently the most commonly used technique and is a highly accurate method for blood glucose monitoring. Minimally invasive techniques involve attaching electrodes to the skin tissue. This method is not preferred due to its low accuracy and poor signal to noise ratio (SNR) even though this electronic method reduces the chances of infection and minimizes the pain. Among the available non-invasive techniques absorption spectroscopy is mostly used to observe scattering, absorption, reflection and refraction of light when it is focused on biological tissues. The characteristics of light depend on the chemical composition and structure of the sample.

When the beam is passed through the sample, the weak coherent laser light is coupled to a fiber and then connected to a photon counting system. This research demonstrated that the photon counts per second and glucose concentration have a linear correlation in samples with glucose concentrations from 10 mg.dL-1 to 260 mg.dL-1.

The measured output voltage from photo-sensor increased with increasing glucose concentrations. In this experiment, in-vivo results are generated using human finger and observed the output voltage variations before and after a meal for both the aforementioned wavelengths.

In this paper, the suitable wavelength of laser light for BGM and spo2 measurement is investigated by determining the transmittance and absorbance of various wavelengths when passed through water and the human finger. On the basis of this suitable wavelength, a simple, non-invasive, cost effective blood glucose level detection technique and device based on the variations in the refractive index

of red laser light is presented. Intensification of glucose concentration increases the refractive index which consequently steps up the output voltage at the photo-sensor. The variations in output voltage are converted into equivalent glucose concentrations level. Hardware for both in-vitro and in-vivo cases have been fabricated and tested.

II. PROPOSED METHOD

In this paper, the suitable wavelength of laser light for BGM and spo2 measurement is investigated by determining the transmittance and absorbance of various wavelengths when passed through water and the human finger. On the basis of this suitable wavelength, a simple, non-invasive, cost effective blood glucose level detection technique and device based on the variations in the refractive index of red laser light

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TRANSMITTING SECTION

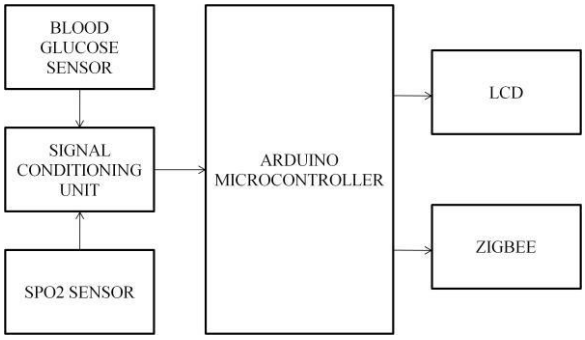

Fig.Block diagram of transmitting section.

RECEIVING SECTION

Fig.Block diagram of receiving section.

The designed device has been tested for both in vitro and in vivo cases and several experimental results have been generated to ensure the accuracy and precision of the proposed sensor.

2.PERFORMANCE METRICS

LASER DIODE

Laser is of prime importance in Optical memories, Fiber optic communications, Military applications, Surgical procedures, CD players, Printers etc. Various forms of lasers like Gallium Arsenide laser, Helium Neon laser, Carbon dioxide laser etc are used in various applications. CD players use laser technology to read the optically recorded data in the form of Bits and Pits on the CD.

Laser is a narrow beam of Photons emitted by specially made laser diodes. Laser diode is similar to an ordinary LED, but it generates a beam of high intensity light. A laser is a device in which a number of atoms vibrate to produce a beam of radiation in which all the waves have single wavelength and are in Phase with each other.

PHOTO DIODE

A photodiode is a kind of light detector, which involves the conversion of light into voltage or current, based on the mode of operation of the device.

It consists of built-in lenses and optical filters, and has small or large surface areas. With an increase in their surface areas, photodiodes have a slower response time. Conventional solar cells, used for generating electric solar power, are a typical photodiode with a large surface area.

A photodiode is a semi-conductor device, with a p-n junction and an intrinsic layer between p and n layers. It produces photocurrent by generating electron-hole pairs, due to the absorption of light in the intrinsic or depletion region. The photocurrent thus generated is proportional to the absorbed light intensity.

LCD DISPLAY

Liquid crystal displays (LCDs) have materials which combine the properties of both liquids and crystals. Rather than having a melting point, they have a temperature range within which the molecules are almost as mobile as they would be in a liquid, but are grouped together in an ordered form similar to a crystal.

An LCD consists of two glass panels, with the liquid crystal material sand witched in between them. The inner surface of the glass plates are coated with transparent electrodes which define the character, symbols or patterns to be displayed polymeric layers are present in between the electrodes and the liquid crystal, which makes the liquid crystal molecules to maintain a defined orientation angle.

One each polarizer's are pasted outside the two glass panels. These polarizer's would rotate the light rays passing through them to a definite angle, in a particular direction When the LCD is in the off state, light rays are rotated by the two polarisers and the liquid crystal, such that the light rays come out of the LCD without any orientation, and hence the LCD appears transparent. When sufficient voltage is applied to the electrodes, the liquid crystal molecules would be aligned in a specific direction. The light rays passing through the LCD would be rotated by the polarisers, which would result in activating / highlighting the desired characters.

The LCD's are lightweight with only a few millimeters thickness. Since the LCD's consume less power, they are compatible with low power electronic circuits, and can be powered for long durations. The LCD's don't generate light and so light is needed to read the display. By using backlighting, reading is possible in the dark. The LCD's have long life and a wide operating temperature range. Changing the display size or the layout size is relatively simple which makes the LCD's more customer friendly. The LCDs used exclusively in watches, calculators and measuring instruments are the simple seven-segment displays, having a limited amount of numeric data. The recent advances in technology have resulted in better legibility, more information displaying capability and a wider temperature range. These have resulted in the LCDs being extensively used in telecommunications and entertainment electronics. The LCDs

have even started replacing the cathode ray tubes (CRTs) used for the display of text and graphics, and also in small TV applications.

SIGNAL CONDITIONING UNIT

The signal conditioning unit accepts input signals from the analog sensors and gives a conditioned output of 0-5V DC corresponding to the entire range of each parameter. This unit also accepts the digital sensor inputs and gives outputs in 10 bit binary with a positive logic level of +5V. The calibration voltages* (0, 2.5 and 5V) and the health bits are also generated in this unit. Microcontrollers are widely used for control in power electronics. They provide real time control by processing analog signals obtained from the system. A suitable isolation interface needs to be designed for interaction between the control circuit and high voltage hardware. A signal conditioning unit is which provides necessary interface between a high power grid inverter and a low voltage controller unit.

3.EXPERIMENTAL RESULTS AND DISCUSSION

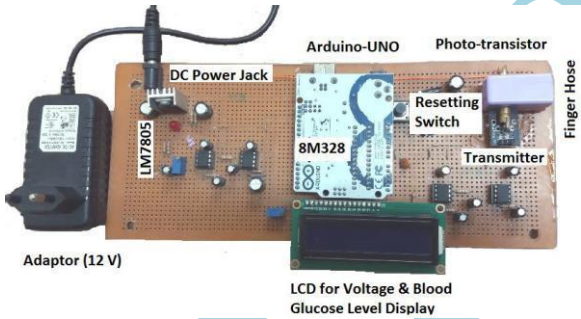

Fig.Snapshot of kit.

4.CONCLUSION

The progress in science & technology is a non-stop process. New things and new technology are being invented. As the technology grows day by day, we can imagine about the future in which thing we may occupy every place.The proposed system based on Arduino microcontroller is found to be more compact, user friendly and less complex, which can readily be used in order to perform. Several tedious and repetitive tasks. Though it is designed keeping in mind about the need for industry, it can extended for other purposes such as commercial & research applications. due to the probability of high technology (arduino microcontroller) used this" a non invasive blood glucose monitoring and spo2 measurement by using laser light" is embedded system. The feature makes this system is the base for

future systems.The principle of the development of science is that "nothing is impossible". So we shall look forward to a bright & sophisticated world.

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