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NON INVASIVE GLUCOMETER WITH INSULIN AND GLUCOSE INJECTOR AND MEASUREMENT OF SIGNIFICANT VITAL SIGNS

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Abstract

India is termed as the "Diabetic capital of the world", as it is one of the lives harmful diseases in the world. The survey ensures that over 30 million people including adults and the elderly have now been diagnosed in India with diabetes. In a rural area, their prevalence is approximately 3 percent of the total population following by 9 percent in urban areas respectively. The commonly used glucose measurement is an invasive and minimally invasive technique as it is highly prominent in accuracy and cost-effective since the device measures the glucose level in contact with the blood directly. On contrary to the advantages, the minimally invasive device may be a painful procedure and sometimes results in infections. Addressing those demerits our research will provide a pathway to develop a non-invasive device with a laser module. By using this device, if an individual has Hypoglycemia Glucose are going to be injected or for Hyperglycemia Insulin are going to be injected. The extra feature is to live vital sign, Heart rate, Temperature, Spo2 and if the dialyzer has blood leakage then the Buzzer will ring. Normally glucometers are used for the diagnostic purpose by adding Insulin and Glucose injector our work will implement and include therapeutic technique.

Keywords - Diabetics, Invasive, Minimally invasive, Non-invasive, Laser module, Dialyzer.

1. INTRODUCTION

Diabetes commonly referred to as a group of metabolic disorders characterized by a high blood sugar level over a chronic period. Symptoms often include frequent urination, increased thirst, and increased appetite. If left untreated, diabetes can cause many complications. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death. Serious long-term complications include upset, stroke, chronic nephropathy, foot ulcers, damage to the nerves, damage to the eyes, and cognitive impairment. Diabetes is because of either the pancreas not producing enough insulin or the cells of the body not responding properly to the insulin produced.

It can even result in many complications like cardiovascular, neurological, and ocular. Diabetes consists of three types:

Type 1: Insulin-dependent diabetes.

Type 2: Non - Insulin-dependent diabetes.

Type 3: Malnutrition related diabetes.

In general, Glucometer is distinguished in three different techniques;

a). Invasive technique:

A procedure that invades (enters) the body, usually by cutting or puncturing the skin or by inserting instruments into the body. Hypodermic injection (using the syringe), an endoscope, percutaneous surgery which involves needle puncture of the skin, laparoscopic surgery commonly called keyhole surgery, a coronary catheter, angioplasty, and stereotactic surgery are some well-known samples of the invasive technique. Invasive procedures are painful, infectious, and inconvenient to the patient.

b). Minimally Invasive technique:

Surgery that's done using small incisions (cuts) and few stitches. During minimally invasive surgery, one or more small incisions could also be made within the body. Adrenalectomy to get rid of one or both adrenal glands, Cancer surgery, to get rid of the tumor, Anti-reflux surgery, sometimes called diaphragmatic hernia repair, to alleviate reflux disease, and Colectomy to get rid of parts of a diseased colon are few samples of the minimally invasive technique.This kind of surgery offers patients several benefits like smaller incisions, faster recovery times, reduced pain, and scarring. In many cases, minimally invasive surgery also offers a better accuracy rate compared to traditional open surgery.

c). Non-Invasive technique:

A non-invasive could be a conservative treatment that doesn't require an incision into the body or the removal of tissue. A medical procedure is defined as non-invasive when no break in the skin is created and there is no contact with the mucosa, or skin break, or internal body cavity beyond a natural or artificial body. X-rays, a standard eye exam, CT scan, MRI, ECG, Holter monitoring, and devices include hearing aids, external splints. This technique is a painless, infection-free, and convenient procedure for the patient.

The main objectives are,

i. The Non- Invasive Glucometer is used to measure the level of glucose in blood without a painful procedure.
ii. By assisting this device children and women can find the glucose level in blood without a painful procedure.
iii. It helps to find the accurate level of glucose in the blood for pregnant women.
iv. The glucose or insulin will be injected by this device if the patient has hypoglycemia or hyperglycemia respectively.
v. In dialyzer, if the blood leakage occurs the automatic buzzer will be rung.

The existing techniques are as follows,

a). Minimally Invasive (Blood using Lancet)

In this technique, the lancet device is used to prick. Load a new lancet into the finger pricker or lancing device. It snaps in there; loads a test strip into the blood glucose meter.

b). Biosensor (Saliva)

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Saliva-based glucose test for diabetes management that measures glucose in saliva rather than blood. The saliva-based glucose test is being developed to improve the quality of life for over 425 million people living with diabetes globally.

Normal glucose levels in saliva are 0.5–1.00 mg/100 ml and do not considerably have an effect on oral health or support the growth of microorganisms. The Glucose Biosensor Unit is a small, disposable strip, which when exposed to an individual's saliva instantly provides a glucose measurement. The glucose measurement will be presented in real-time, via a proprietary digital app on a patient's smart device.

c). Biosensor (Body sweat)

Glucose is also present in sweat; sweat-based glucose sensors offer a non-invasive alternative. Sensors that detect glucose in this way have been developed but suffer from slow analysis time and unstable electrochemical measurement.

d). Test strip (Urine)

A urine glucose test can tell you whether there is glucose (sugar) in the urine and gives an indication of the glucose level. If glucose is found in your urine it is called glycosuria or glucosuria. Glucose is usually only found in the urine when blood glucose levels are raised due to diabetes.

2. METHODOLOGY

The laser module emits the laser light that can penetrate the glucose in the bloodstream. After penetration, the laser light will be absorbed by the photodiode. This photodiode will convert the laser light into an electrical signal. This electrical signal is boosted by the amplifier then the amplified signal is sent to the microcontroller. The microcontroller using the PICKIT2 to analyze the amplified signal. The analyzed signal from the microcontroller was displayed on the LCD screen and transmits through the IOT module to the caretaker and doctor. If the analyzed signal is low, the glucose relay was activated. If the analyzed signal is high, the insulin relay was activated. The LED and LDR were placed on the blood-flowing tube. The LED emits light to the blood-flowing tube and the LDR captures light from the blood-flowing tube. If blood leakage occurs, the LDR detects a varied light signal from the blood-flowing tube. That signal was amplified and sends to the microcontroller. The microcontroller analyzed the signal and activated the buzzer when the blood leakage occurs from the blood-flowing tube.

a). Laser Module (OPV300)

A Laser Diode is a semiconductor device similar to a light-emitting diode (LED). It uses a p-n junction to emit coherent light in which all the waves are at the same frequency and phase. This coherent light is produced by the laser diode using a process termed as "Light Amplification by Stimulated Emission of Radiation", which is abbreviated as LASER. And since a p-n junction is used to produce laser light, this device is named a laser diode. The red color laser light is generated through the laser module. The red laser light has an 850 nm wavelength.

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Fig: Laser Module (OPV300)

The laser light penetrates the glucose molecule. When this happen the glucose molecule involve some reaction like wagging, bending, stretching and twisting. By this reactions the laser light loss it's energy. This energy loss based on the amount of glucose molecule present in blood stream. The amount of glucose molecule directly propositional to the energy loss by the reactions

b). Light-Dependent Resistor (GL5528)

Photoresistors, also known as light-dependent resistors (LDR), are light-sensitive devices most often used to indicate the presence or absence of light or to measure the light intensity. In the dark, their resistance is very high, sometimes up to 1MΩ, but when the LDR sensor is exposed to light, the resistance drops dramatically, even down to a few ohms, depending on the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied and are nonlinear devices. They are used in many applications but are sometimes made obsolete by other devices such as photodiodes and phototransistors. Some countries have banned LDRs made of lead or cadmium over environmental safety concerns. The LDR GL5528 has specific light depending resistance of 10-20K/1M ohm.

Fig: Light-Dependent Resistor (GL5528)

c). Instrumentation Amplifier (AD8223)

An Instrumentation amplifier is a type of differential amplifier that has been outfitted with input buffer amplifiers, which eliminate the need for input impedance matching and thus make the amplifier particularly suitable for use in measurement and test equipment. Additional characteristics include very low DC offset, low drift, low noise, very high open-loop gain, very high common-mode rejection ratio, and very high input impedances. Instrumentation amplifiers are used where great accuracy and stability of the circuit both short and long-term care required. The AD8223 is an integrated single-supply instrumentation amplifier that delivers rail-to-rail output swing on a single supply (3 V to 24 V). The AD8223 conforms to the 8-lead industry-standard pin-out configuration. The

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AD8223 has a wide input common-mode range and can amplify signals that have a 150 mV common-mode voltage below ground.

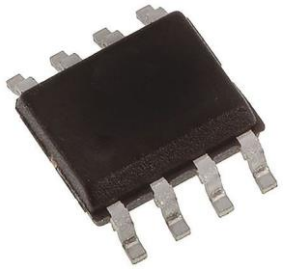

Fig: Instrumentation Amplifier (AD8223)

d). PIC Microcontroller (16F877A)

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1640.Originally developed by General Instrument's Microelectronics Division. The name PIC initially referred to "Programmable Interface Controller". The microcontroller is a general-purpose device, which integrates a number of the components of a microprocessor system on to single chip. It has an inbuilt CPU, memory, and peripherals to make it a mini-computer. A microcontroller combines on to the same microchip. CPU core. Memory (both ROM and RAM). Temperature Range (°C) is -40 to 125 and Operating Voltage Range 2 to 5.5.

Fig: PIC Microcontroller (16F877A)

e). Power Supply

The input to the circuit is applied from the regulated power supply. The AC input that is 230V from the main supply is step down by the transformer to 12V and is fed to a rectifier. The output obtains from the rectifier is a pulsating DC voltage. So to gate a pure DC voltage, the output voltage from the rectifier is fed to a filter to remove ripples present even after rectification. Voltage regulator LM7805 is used to regulate the 5V constantly and continuously. The bridge rectifier GBJ2510 was used to convert AC signal into DC signal with constant voltage 5V.

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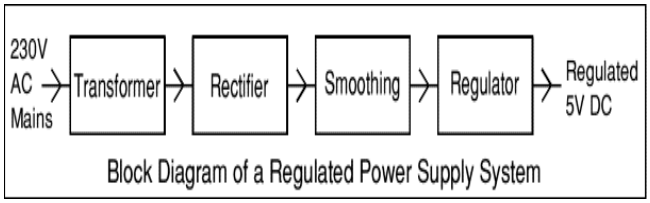

Fig: Power Supply

f). IoT Module (ESP 8226-12E)

NodeMCU is an open-source IoT platform. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the dev kits. The firmware uses the Lua scripting language. It is based on the eLua project and built on the Espressif Non-OS SDK for ESP8266.

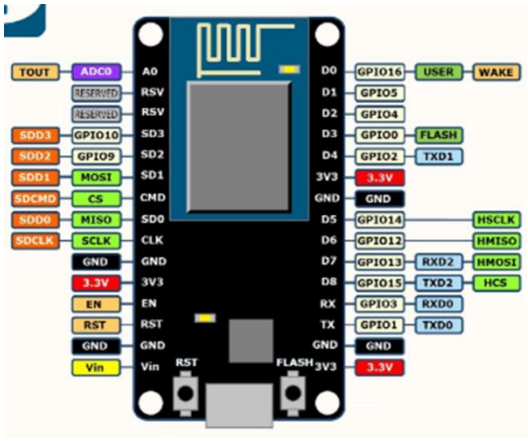

Fig: IOT Module (ESP 8226-12E)

g). Buzzer-12VAC

A buzzer or beeper is a signaling device, usually electronic, typically used in automobiles, household appliances such as a microwave oven, or game shows. The word "buzzer" comes from the rasping noise that buzzers made when they were electromechanical devices, operated from stepped-down AC line voltage at 50 or 60 cycles. Other sounds commonly used to indicate that a button has been pressed are a ring or a beep.

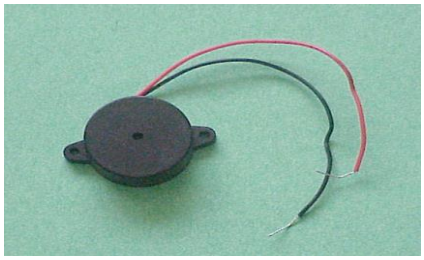

Fig: Buzzer-12VAC

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h). LCD Display 1602

Liquid crystal displays (LCDs) are used in similar applications where LEDs are used. These applications are a display of numeric and alphanumeric characters in dot matrix and segmental displays. The liquid crystal material may be one of the several components, which exhibit optical properties of a crystal though they remain in liquid form. Liquid crystal is layered between glass sheets with transparent electrodes deposited on the inside faces.

Fig: LCD Display 1602

l). Heartbeat Sensor BH1790GLC

Heartbeat sensor The sensor consists of a super bright red

i). Relay Driver

The transistor is a compound structure consisting of a transistor connected in such a way that the current is amplified by the transistor. This configuration gives a much higher current gain (written β, hfe, or hFE) than each transistor taken separately and, in the case of integrated devices, can take less space than two individual transistors because they can use a shared collector.

Fig: Relay Driver

j). Single shaft BO Motor

A DC motor is any of a class of rotary electrical motors that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current in a part of the motor. Operating Voltage: 3 to 12V.Current (without loading): 40-180mA. RPM: 60 rpm k).

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Fig: Single shaft BO motor

k). LED 1550E

A light-emitting diode (LED) is a semiconductor light source that emits light when current flows through it. Electrons in the semiconductor recombine with electron holes, releasing energy in the form of photons. The color of the light (corresponding to the energy of the photons) is determined by the energy required for electrons to cross the band gap of the semiconductor. White light is obtained by using multiple semiconductors or a layer of light-emitting phosphor on the semiconductor device.

Fig: LED 1550E

Fig: heartbeat sensor BH1790GLC

LED and a light detector. The heartbeat sensor is placed in the index of the finger nose & the output of the heart sensor is connecting to the PIC microcontroller RB0th PIC. When the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the

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detector. With each heart pulse, the detector signal varies. This variation is converted to an electrical pulse. It works on the principle of light modulation by blood flow through the finger at each pulse.

5. RESULT

In this paper, a non-invasive glucose measurement device is based on a laser with a frequency of 850 nm, which offers several advantages such as the absence of pain and exposure to sharp objects. This indicates as feasible to measure blood glucose level non-invasive.

Technique	Advantages	Future scope	Drawbacks
Chip less tag sensor	Non-invasive Wearable Zero power consumption High sensitivity	Non-invasive sensor technology	Low dehydration
Impedance spectroscopy	Low cost Wearable	Reliable Non-invasive Real time monitoring	Overall accuracy is not high enough for commercial uses
Near infrared technology	Standard output voltage	More accurate and reliable result	Complicated structure
Photoplethysmography optical sensor	Affordable and easily accessible	Advancement in clinical application	Not reliable Sensitivity to environment conditions
Multisensor	Painless Risk free Continuous monitoring	Time delay	Physical discomfort Infection risk
Saliva nano sensor	Simple structure Excellent accuracy	Real time monitoring Convenient Salivary and glucose tracking at any time	Based on age, gender and medical condition

Table: comparison of techniques

The output of this gives a value of glucose in the blood and injects insulin or glucose of a person has hypoglycemia or hyperglycemia, by adding if the dialyzer has the blood leakage that produces the buzzer to make noise and IOT module is used to store and send the data of the patient to the doctor. Including the feature that it measures the temperature, heart rate, and pulse rate. Mostly the sensor technology used in glucose measurement otherwise an invasive or minimally invasive techniques are used. Also there is no therapeutic procedure along with a diagnostic procedure in glucose measurement. If the diagnostic and therapeutic procedure in same device, it'll be time saving procedure.

In optical sensor technology, the optical light will be distracted by the environmental condition or the optical system is highly sensitive to the environment. So, the accuracy will be drastically low as well as reliability. Some of the sensor techniques are actually invasive or minimally invasive so that this leads to inconvenient and infection to the user or patient.

CONCLUSION

Vital sign monitoring with the therapeutic device will be an advance technique in medicine field. We planned to implement the therapeutic procedures for each and every vital sign monitoring system. Dialysis blood leakage monitoring along with glucose monitoring will be an advance technique. If we combine more monitoring system in a single device that will be a time saving process. Instead of using optical system, we can use the laser module for better accuracy and reliability as well as it reduces the infection to the patient. **Acknowledgement**

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