Non-Invasive Glucometer

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***Abstract*— This project is focused on developing a non-invasive, low-cost method for monitoring blood glucose levels using near-infrared (NIR) light. The project utilizes a NIR light source to penetrate the skin and detect glucose molecules in the blood vessels. The intensity ratio between absorbed NIR in glucose molecules and scattered NIR light in the photodetector is used to calculate the glucose level. The measured glucose level is displayed on an LCD screen and transmitted wirelessly to a smartphone app using the Blynk platform. This project has the potential to revolutionize blood glucose monitoring for individuals with diabetes, making the process easier, more accessible, and less painful.**

Keywords- Buzzer, Lcd, Node-MCU, NIR Light, Photodetector

I. INTRODUCTION

This project is designed to measure blood glucose levels non-invasively using near-infrared (NIR) light. The purpose of this project is to offer a convenient and pain-free way for diabetic patients to monitor their blood glucose levels.

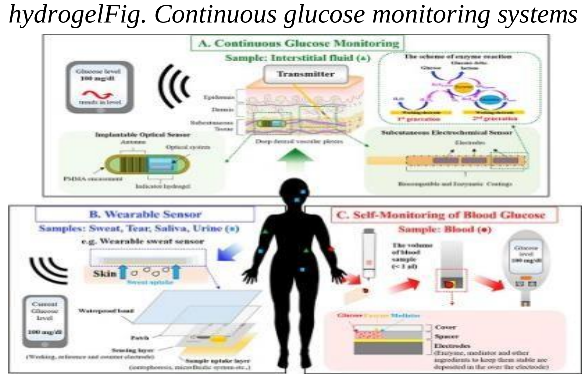
The system is composed of an NIR light emitter, a photodetector, and an amplifier circuit. The NIR light emitter sends light through the patient's fingertip, and the photodetector receives the light that passes through the finger. The amplifier circuit amplifies the signal and then calculates the glucose concentration based on the intensity ratio between the absorbed NIR light in glucose molecules and the scattered NIR light in the photodetector.

In addition to the hardware components, the project also includes a software component that displays the glucose level on an LCD screen and sends the data to a mobile app using the Blynk platform. The mobile app can be used to track and monitor the patient's glucose levels over time.

Overall, this project offers a low-cost, non-invasive, and convenient way for diabetic patients to monitor their blood glucose levels, potentially improving their quality of life and health outcomes.

II. LITERATURE REVIEW

[1]Inyoung Lee, David Probst, David Klonoff, Koji Sode aim to develop Continuous glucose monitoring systems. Diabetes mellitus is a chronic illness in the United States affecting nearly 120 million adults, as well as increasing in children under the age of 18. Diabetes was also the 7th leading cause of death in the United States with 270 K deaths in 2017. Diabetes is best managed by tight glycemic control, as achieving near-normal glucose levels is key to reduce the risk of microvascular complications. Currently, continuous glucose monitoring (CGM) systems have been recognized as the ideal monitoring systems for glycemic control of diabetic patients. Briefly, a CGM system measures blood glucose levels in subcutaneous tissue by attaching a CGM sensor to the skin, allowing the users to make appropriate modifications to their medical interventions according to experience or empirically derived algorithms. The principles of the glucose sensing employed in the current commercially available CGM systems are mainly electrochemical, and employ the gold standard enzyme, glucose oxidase, as the glucose sensing molecule with the combination of hydrogen peroxide monitoring or with the combination of redox mediator harboring hydrogelFig. Continuous glucose monitoring systems



[2]Dziergowska, Katarzyna on develop theModern noninvasive methods for monitoring glucose levels in patients. in recent years, we can observe constant increase in the incidence of diabetes. About 40% of all

performed blood tests apply to the glucose tests. Formerly, this lifestyle disease occurred mainly in rich countries, but now it is becoming more common in poorer countries. It is related to the increase in life expectancy, unhealthy diet, lack of exercise, and other factors. Untreated diabetes may cause many complications or even death. For this reason, daily control of glucose levels in people with this disorder is very important. Measurements with a traditional glucometer are connected with performing finger punctures several times a day, which is painful and uncomfortable for patients. Therefore, researches on other methods are ongoing. A method that would be fast, noninvasive and cheap could also enable testing the state of the entire population, which is necessary because of the number of people currently living with undiagnosed type 2 diabetes. Although the first glucometer was made in 1966, the first studies on glucose level measurement in tear film were documented as early as 1937. This shows how much a noninvasive method of diabetes control is needed. Since then, there have been more and more studies on alternative methods of glucose measurement, not only from tear fluid, but also from saliva, sweat, or trans dermally.

[3] Shang, T., Zhang, J.Y on develop the Products for monitoring glucose levels in the human body with noninvasive optical, noninvasive fluid sampling, or minimally invasive technologies. : In order to identify such products, four different sources were used: (1) PubMed, (2) Google Patents, (3) Diabetes Technology Meeting Startup Showcase participants, and (4) experts in the field of glucose monitoring. The information obtained were filtered by using two inclusion criteria: (1) regulatory clearance, and/or (2) significant coverage in Google News starting in the year 2016, unless the article indicated that the product had been discontinued. The identified bloodless monitoring products were classified into three categories: (1) noninvasive optical, (2) noninvasive fluid sampling, and (3) minimally invasive devices.

III. PROBLEM IDENTIFICATION AND SOLVED

The problem with traditional methods for monitoring glucose levels, such as finger pricks, is that they are invasive, painful, and inconvenient. This has led to a need for non-invasive, more comfortable, and convenient methods of glucose monitoring. This project addresses this problem by utilizing Near Infrared Spectroscopy (NIRS) to non-invasively measure glucose levels in the blood.

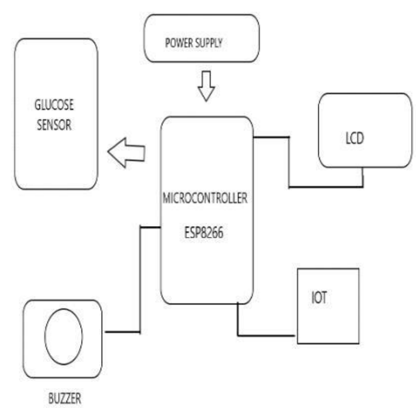
The NIRS system consists of a light source that emits NIR light, a photodetector that detects the NIR light that passes through the skin, and an amplifier that amplifies the signal. The NIR light is absorbed by the glucose molecules in the blood, which produces a unique signature that can be measured by the photodetector. By measuring the intensity ratio of the absorbed NIR light to the scattered NIR light in the photodetector, the glucose level in the blood can be determined.

The goal of this project is to provide a more comfortable and convenient method for individuals to monitor their glucose levels. This will improve their quality of life and enable them to more easily manage their diabetes.

IV. PROPOSED METHODOLOGY

The proposed methodology of this project involves the use of Near-Infrared (NIR) spectroscopy to non-invasively measure glucose levels in the blood.

The steps involved in the methodology are: NIR Light Source: The first step is to provide a NIR light source to the finger. The source used is a LED with a wavelength of 940 nm, which is within the absorption range of glucose molecules. The light passes through the finger and reaches the photodetector. Photodetector: A photodetector is used to detect the intensity of NIR light that passes through the finger. A PIN photodiode is used for this purpose as it has high sensitivity and a quick response time.



Signal Amplifier: The detected signal is very weak, and hence, it needs to be amplified for further processing. An operational amplifier (op-amp) is used for this purpose, which amplifies the signal by a factor of 100.

Signal Processing: The amplified signal is then processed using a microcontroller (MCU). The MCU reads the analog voltage from the op-amp and converts it to a digital value. The digital value is then used to calculate the glucose level using an algorithm.

Glucose Level Calculation: The glucose level is calculated using the intensity ratio method. The intensity of the NIR light that passes through the finger is compared with the intensity of the reference signal, which is the NIR light that does not pass through the finger. The ratio of these intensities is used to calculate the glucose level.

Output Display: The glucose level is displayed on an LCD screen, which is connected to the MCU.

The proposed methodology is non-invasive and provides a reliable and method of measuring glucose levels in the blood. It eliminates the need for painful and invasive methods such as finger pricks, which are currently the standard method for glucose level measurement. The methodology is also cost-effective and can be used in remote areas where access to medical facilities is limited.

V. BLOCK DIAGRAM

Fig. Non-invasive Glucometer Block Diagram

VI. FLOW CHART

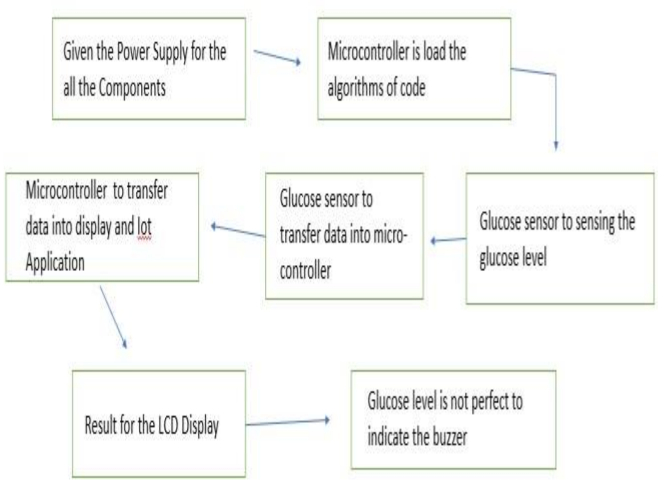
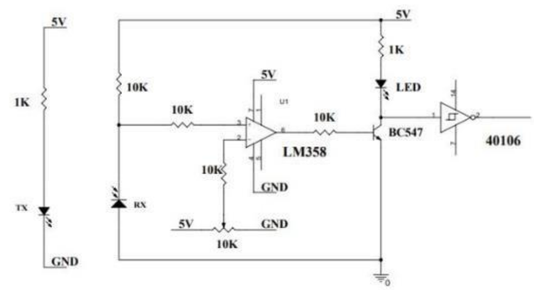


Fig. Flow Chart

VII. CIRCUIT DIAGRAM

Fig. Glucose Sensor Circuit Diagram



VIII. SPECIFICATION

Node-MCU: This is a development board based on the ESP8266 Wi-Fi module. It has a built-in WIFI antenna and can be programmed using the Arduino IDE.

Power separation board: This board helps to isolate the power supply for the Node-MCU from other components in the circuit. It usually includes voltage regulators and capacitors to ensure stable power supply.

Buzzer: This is an electronic component that produces sound when an electrical signal is applied to it. In your project, the buzzer may be used to alert the user of certain events or conditions.

LCD display: This is a display module that can show characters and graphics. In your project, it may be used to display the glucose level reading.

NIR light and photodetector: These components are used to measure the glucose level non-invasively using near-infrared light. The NIR light is emitted towards the skin, and the photodetector detects the intensity of light that passes through the skin. By analyzing the absorption of NIR light by glucose molecules in the skin, the glucose level can be estimated.

LM358 amplifier: This is an operational amplifier that can be used to amplify and filter the signal from the photodetector. In your project, it may be used to amplify the weak signal from the photodetector and filter out unwanted noise.

<u>Applications and Benefits:</u>

Blynk IoT applications and the benefits of non-invasive glucose monitoring are numerous Blynk is a platform that allows users to control and monitor their IoT devices from anywhere, at any time.

This platform can be used to develop custom applications for non-invasive glucose monitoring, providing patients with greater control and convenience over their health and wellness.

Real-time monitoring: Blynk IoT applications allow patients to monitor their glucose levels in real-time, providing them with up-to-date information about their health.

Improved management: By having access to real-time glucose data, patients can make more informed decisions about their diabetes management, reducing the risk of complications.

Increased engagement: By providing patients with access to real-time glucose data, Blynk IoT applications can increase patient engagement and motivation, leading to better health outcomes.

Reduced healthcare costs: Non-invasive glucose monitoring can reduce the need for frequent office visits, reducing healthcare costs and improving access to care.

The use of Blynk IoT applications in non-invasive glucose monitoring offers numerous benefits, including real-time monitoring, improved management, increased engagement, and reduced healthcare costs. By leveraging the power of the internet and mobile technology, patients can better manage their diabetes and improve their health outcomes.

Future Developments and Research:

Future developments and research in non-invasive glucose monitoring aim to improve accuracy and reliability of glucose sensors, enhance patient comfort and ease of use, and integrate the technology with various healthcare systems for effective management of diabetes and other glucose-related disorders.

The integration of these technology into compact, portable, and cost-effective glucose monitoring devices could have a significant impact on the management of diabetes and the overall quality of life for those affected by the condition.

Advancements in technology, such as miniaturization of sensors, integration with wearable devices, and improved data analysis algorithms, are expected to shape the future of non-invasive glucose monitoring.

XI. CONCLUSION

In conclusion, non-invasive glucose monitoring is a rapidly growing field that offers a convenient and less painful alternative to traditional glucose monitoring methods.

The technology is based on optical glucose sensors that use light to measure glucose levels in the body. The development and use of non-invasive glucose meters are made possible with the integration of power separation boards, node-mcu boards, lcd displays, and software development in embedded C Although there are still some challenges and limitations to overcome, the future of non-invasive glucose monitoring is promising.

The use of non-invasive glucose monitoring has the potential to improve the quality of life for people with diabetes and make glucose monitoring a more routine and less stressful process. With advances in technology and continued research and development, non-invasive glucose monitoring is likely to become a common and essential tool for diabetes management.

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