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NON-INVASIVE GLUCOSE MONITORING WITH BUILT IN INSULIN DISPENSER

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ABSTRACT-

The invasive nature of blood glucose monitoring (BGM) procedures stems from the need for a finger prick blood sample, an uncomfortable procedure that can lead to illness. BGM is necessary to prevent issues in diabetic individuals that result from abnormal blood glucose levels. Laser light-based sensors are proven to offer better BGM potential. Due to its drawbacks, which include reduced accuracy, higher signal-to-noise ratio, and light absorption in human tissue, existing near-infrared (NIR)-based BGM approaches have not been used for commercial BGM applications. This work describes the implementation of a straightforward, small, and reasonably priced non-invasive device for BGM that uses visible red laser light with a wavelength of 650 nm (RL-BGM). There are three main technical advantages of the RL-BGM monitoring device over NIR. Red laser light has a transmission through human tissue that is around thirty times better than NIR. Moreover, the refractive index of laser light is more responsive to changes in glucose concentration than NIR, leading to faster response times of about 7–10 s. Additionally, red laser light exhibits better BGM linearity and accuracy.

Keyword: Red laser light, Visible Red Laser Light BGM, Glucose Concentration Detection, Blood Glucose Monitoring Accuracy, Laser light sensors For Diabetes, Transmittance through human tissue.

I.INTRODUCTION :

DIABETES or 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. Approximately US $ 376 billion is spent annually in the US on the treatment and management of diabetes in diabetic patients and this amount is expected to rise to a projected US$ 490 billion by the end of 2030. Diabetes is a type a metabolic diseases in which the blood glucose (blood sugar) level in human body increases drastically from its normal level. The increase in sugar level is either due to inadequate production of insulin in blood cells or can be because of improper response of body cells to the insulin or can be because of both the reasons. Diabetes can lead to major complications like heart failure and blindness in the human body . Hence regular monitoring of glucose level is important. The World Health Organization (WHO) estimated that the number of people with diabetes is more than 200 million. Diabetes is a state of a body where it not able to produce the quantity of insulin sufficiently required to maintain normal level of blood glucose. So, diabetic patients regulate their blood glucose levels through proper diet as well as by injecting insulin.

For the effective treatment of diabetes, patients have to measure the level of blood glucose periodically. At present, diabetic persons are using invasive figure pricking instrument knows as glucose meter to know the concentration of blood glucose.According to the International Diabetes Federation (IDF) the diabetes patients in 2011 are 366 million worldwide and this number is expected to rise to 552 million by 2030. 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.

II. METHODOLOGY

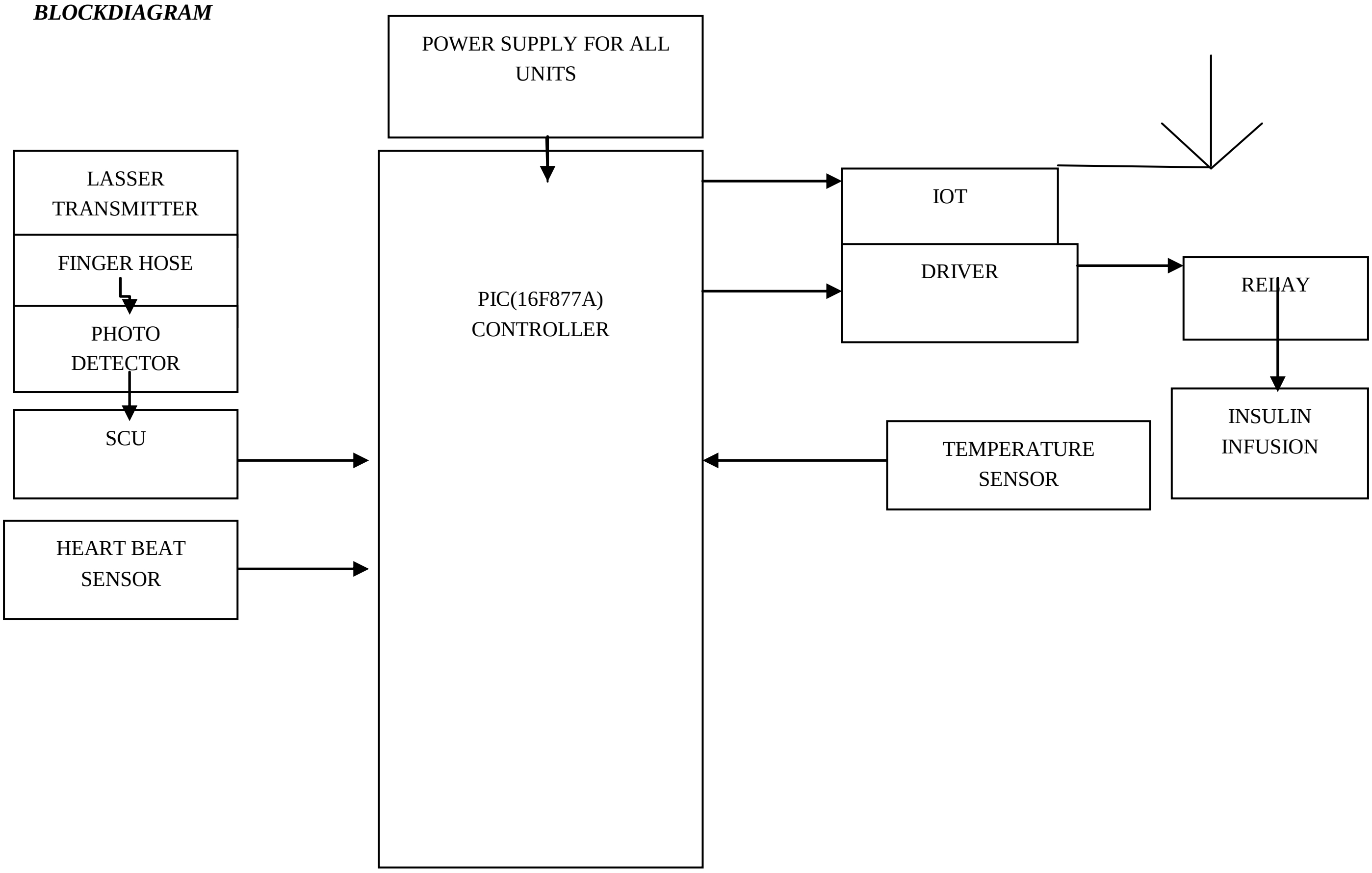
EXISTING SYSTEM

This published work detailed the noninvasive blood sugar testing method in humans using multiple approaches. Along with noise filtering techniques, the non-invasive measurement device's measurement accuracy is crucial. Light is dimmed when it interacts with human body tissues because of both tissue absorption and dispersion. Light scattering happens in tissues as a result of a discrepancy between the refraction index of extracellular fluid and the cell membrane. Whereas the cellular membrane index is thought to stay mostly constant, the extracellular fluid's refraction index changes with the concentration of glucose. Lambert-Beer The law, which states that the absorbance of light through any solution is proportionate to the solution's concentration and the length of the light ray's course, is important in the measurement of absorbance.

PROPOSED SYSTEM

Recent advancements aim to address the pain and infection risks of invasive glucose meters, with non-invasive blood glucose monitoring becoming a significant research focus. This system employs a PIC16F877A microcontroller and uses visible red laser light to measure glucose levels across a finger hose, chosen for its small thickness and absence of bone. Light transmission, varying with blood glucose levels, is detected on either side of the hose. Additionally, a heartbeat sensor and temperature sensor monitor the patient's vital signs. An integrated insulin pump delivers precise insulin doses, halting automatically when glucose levels are low and the user is unresponsive to alarms, providing enhanced protection against severe hypoglycemia. Sensor data is monitored via the Blynk app using IoT.

BLOCKDIAGRAM



III.WORKING MODEL EXPLANATION

The RL-BGM device uses a 650 nm visible red laser light to non-invasively measure blood glucose levels through a finger hose, chosen for its minimal thickness and absence of bone. The laser light passes through the finger, and the amount of light detected correlates with blood glucose concentration. Controlled by a PIC16F877A microcontroller, the system processes the signal to provide glucose readings within 7-10 seconds, leveraging the higher transmittance and sensitivity of red laser light for enhanced accuracy. Integrated with heartbeat and temperature sensors, the device can monitor vital signs and automatically adjust an insulin pump based on glucose levels, with data accessible via a smartphone app like Blynk for remote monitoring and alerts.

Software Development:Arduino Programming: Write code to read data from sensors and transmit it using the Wi-Fi module to the Blynk cloud. Example libraries include Wire for I2C communication, WiFi.h for Wi-Fi connectivity, and BlynkSimpleEsp8266.h for Blynk integration.Machine Learning Model:Data Collection and Preprocessing: Collect historical patient data including physiological parameters and anesthesia dosage. Preprocess this data to train the model.Model Training: Use a suitable ML algorithm (e.g., regression, decision trees, or neural networks) to train a model that predicts the required anesthesia dosage based on physiological parameters.Model Integration: Deploy the trained model in a server or edge device that can process incoming data from the Arduino and provide dosage predictions.

IV.RESULT AND DISCUSSION

The innovative integration of non-invasive glucose monitoring with automated insulin delivery exemplifies a significant advancement in diabetes management, potentially revolutionizing patient care. Utilizing laser light transmittance through the finger for glucose measurement offers a less invasive and more patient-friendly alternative to traditional methods, enhancing patient compliance and comfort. The strategic selection of the finger hose, devoid of bone tissue and with its minimal thickness, ensures accurate and efficient light penetration, making it an ideal site for such measurements. Central to this system is a highly advanced insulin pump that not only delivers precise doses of insulin based on real-time glucose readings but also incorporates critical safety mechanisms.

These mechanisms are designed to prevent hypoglycemic events by automatically halting insulin delivery when glucose levels fall below a safe threshold, a feature especially crucial during periods of sleep. The seamless integration of a laser module and photodiode translates optical properties into actionable data, subsequently analyzed and processed by an Arduino microcontroller. This process culminates in the display of glucose levels on an LCD screen and the transmission of this data to healthcare providers via IoT technology, enabling timely interventions. This holistic approach not only promises to improve the quality of life for individuals living with diabetes by offering a more natural and less intrusive method of managing their condition but also enhances safety with built-in protections against severe low blood glucose levels. As this technology matures, it has the potential to set a new standard in diabetes care, prioritizing both efficacy and patient well-being.

FIG 1.1 OUTPUT 1

FIG 1.2 OUTPUT 2

V.CONCLUSION

The integration of laser-based glucose monitoring, automated insulin delivery, and IoT connectivity represents a significant advancement in diabetes management technology. This system offers a more accurate, efficient, and user-friendly alternative to traditional diabetes management methods, addressing many of the challenges faced by individuals with diabetes.The non-invasive nature of the glucose monitoring, combined with the precision and personalization of the insulin delivery system, significantly enhances the quality of life for users. It minimizes the risks associated with diabetes, such as severe hypoglycemia, and provides a foundation for more consistent and effective diabetes control.Furthermore, the capability for remote monitoring by healthcare providers ensures that patients receive timely care, making this system a powerful tool in the management of diabetes. It not only supports the individual needs of patients but also contributes to the broader goals of healthcare systems to deliver patient-centered, efficient, and effective care.In conclusion, this technology heralds a new era in diabetes management, offering promising prospects for improving patient outcomes, reducing healthcare costs associated with diabetes complications, and ultimately, enhancing the overall well-being of individuals living with diabetes.

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