ISSN: 2278-4632
Vol-13, Issue-06, No.01,June : 2023

NON INVASIVE GLUCOMETER

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Abstract
Diabetes is a common chronic disease in almost all countries of the world. The most commonly used method to measure blood sugar level BGM's is an invasive method, which is painful, expensive and with a risk of spreading infectious diseases. In the long term, the invasive method causes damage to the finger tissues. Alternatively, a non-invasive method can be used, which facilitates repeated tests, relieves the pain and discomfort caused by repeated finger pricks. A non-invasive method for measuring glucose levels is proposed.
The change in NIR light intensity obtained after passing through the finger of the light sensor is used to determine the blood glucose. The measured glucose level is displayed on the LCD screen and also transmitted to the Android application created on the mobile phone to display and save the data via Bluetooth. With this method we can save a lot problem for the old age people who's finger tissue will be less rigid and more painful if you use invasive method. The market has been increased rapidly for the non invasive methodology.
Keywords:LCD, NIR, Bluetooth, BGM.

I. Introduction:

Proper management of diabetes requires regular monitoring of blood glucose levels. Traditional glucose monitoring methods involve pricking the finger and drawing blood for analysis. However, these invasive techniques can be uncomfortable, inconvenient, and may deter individuals from frequent monitoring. As a result, non-invasive glucometers have emerged as an exciting area of research and development. Non-invasive glucometers offer a promising alternative by eliminating the need for painful finger stick testing. They utilize advanced technologies to measure blood glucose levels through non-invasive means such as optical sensors. One such technology is near-infrared spectroscopy (NIRS), which detects changes in blood glucose concentration by analyzing the interaction of near-infrared light with body tissues. NIRS has shown potential in accurately estimating glucose levels without the need for blood sampling.
In recent years, the integration of Bluetooth technology has further enhanced the capabilities of non-invasive glucometers. Bluetooth enables wireless communication between the glucometer and external devices such as smartphones or computers, allowing for real-time monitoring and data transmission. This feature provides individuals with diabetes the convenience of tracking their glucose levels remotely and enables healthcare professionals to access and analyze the data for timely interventions.
Arduino micro controllers, known for their versatility and ease of programming, have become popular platforms for developing innovative medical devices.The Arduino acts as the central processing unit, acquiring and processing data from the optical sensor, estimating glucose levels, and facilitating communication through Bluetooth connectivity.
This integration of non-invasive glucose measurement, NIR sensors, and Bluetooth monitoring holds tremendous potential for revolutionizing diabetes management. Additionally, healthcare professionals can remotely access and analyze the collected data, enabling timely interventions and personalized treatment plans.

II. Literature Review:

Monitoring blood glucose levels is crucial for preventing diabetes complications and organ damage. However, the invasive method of glucose measurement, which involves pricking the finger, is

painful and can cause nerve damage. To address this issue, researchers have explored non-invasive methods as an alternative.

Shinde and Prasad [1] proposed a non-invasive glucose monitoring technique that utilizes near-infrared (NIR) light transmitted through the fingertip. By applying hypersystolic pressure to temporarily stop blood flow for 30 seconds, they studied the response of the optical signal using FFT analysis and a spectrum analyzer.In a review by Chi Fuk So et al. [2], recent advancements in non-invasive glucose measurement were examined, highlighting optical methods as a painless and promising approach for blood glucose monitoring. Jyoti Yadav [3] conducted an experiment using a 940 nm NIR LED light on the human forearm to analyze glucose concentration. They investigated a non-invasive blood glucose meter [4] employing two LED's of the same wavelength, one serving as a light emitter and the other as a photo-detector. Another study [5] evaluated eight pairs of NIR LED's for sensitivity to various glucose concentrations and found that the most efficient pair operated at 1450 nm. Additionally, three different probes (arm, finger, earlobe) were developed for blood sugar measurement using a 940 nm NIR.

[6] Parag Narkhede, Suraj Dhalwar, B. Karthikeyan. “NIR Based Non-Invasive Blood Glucose Measurement”, is a bit useful and [10] Gesture controlled quad copter for defense search operations SB Choubey, A Choubey, CSN Koushik Materials Today is really helpful to understand the concept of embedded systems.In the medical field [11] Shruti Bhargava, Dr. Ajay Somkuwar,noise assessment in medical imaging data ,journal of medical imaging & health informatics ,Volume 6, Number 4 gave new ideas to choose the field.

III. Problem Statement

The traditional method of measuring blood glucose levels through invasive fingerstick testing is discomforting and inconvenient, leading to decreased compliance and reluctance in regular monitoring. There is a need to develop a non-invasive glucometer using Arduino microcontroller and near-infrared (NIR) technology to provide a painless and accessible solution for monitoring blood glucose levels. The problem lies in designing a reliable and accurate system that can effectively measure glucose levels non-invasively using NIR sensors integrated with Arduino. Additionally, the glucometer should be user-friendly, cost-effective, and capable of providing real-time glucose readings. Addressing these challenges will contribute to improving diabetes management by offering a non-invasive and convenient method for individuals to monitor their blood glucose levels accurately and regularly.

IV. Proposed Methodology

Choose appropriate NIR sensors capable of accurately detecting changes in glucose concentrations. Consider factors such as wavelength, sensitivity, and compatibility with Arduino. Connect the NIR sensors to the Arduino microcontroller, ensuring proper wiring and connections. Configure the Arduino board to interface with the sensors and enable data acquisition.

Develop calibration algorithms to establish a correlation between the sensor readings and actual glucose concentrations. Collect a datasets of reference glucose values and corresponding NIR sensor readings for calibration purposes.Set up the Arduino to continuously acquire data from the NIR sensors. Utilize appropriate sampling rates and signal processing techniques to capture and process the NIR signal responses.Design a user-friendly interface, such as a display or smartphone application, to visualize and present the glucose measurements obtained from the Arduino. This allows users to easily interpret and track their glucose levels. Incorporate Bluetooth modules into the Arduino setup to enable wireless communication with external devices, such as smartphones or computers. This facilitates real-time monitoring, data transmission, and remote accessibility of glucose measurements.

ISSN: 2278-4632
Vol-13, Issue-06, No.01,June : 2023

V. Hardware Requirements

- Arduino uno(micro controller)
- Bluetooth(HC-05)
- LED indicator
- LCD display
- Regulated power supply

VI. Software

1.Arduino IDE studio compiler
2.Proteus software

VII. Theory

The theory behind a non-invasive glucometer using Arduino with NIR involves the principles of near-infrared spectroscopy and the utilization of Arduino as a microcontroller for data acquisition and processing. Here is a brief overview of the theory involved:

7.1 Near-Infrared Spectroscopy (NIRS):

Near-infrared spectroscopy is based on the principle that different molecules, including glucose, absorb and scatter light in the near-infrared range (700 nm to 2500 nm). By analyzing the interaction of near-infrared light with body tissues, it is possible to estimate glucose concentrations non-invasively. NIR sensors, typically LED's and photo detectors, are used to emit and detect near-infrared light.

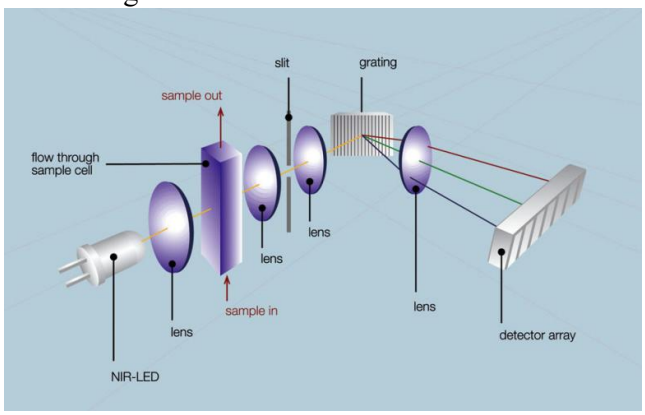

Fig:7.1:NIR

7.2 Light-Tissue Interaction:

When near-infrared light is directed onto body tissues, it interacts with components such as water, lipids, and glucose. The light is either absorbed or scattered depending on the molecular composition and concentration in the tissue. Glucose has specific absorption characteristics in the near-infrared region, allowing it to be differentiated from other components.

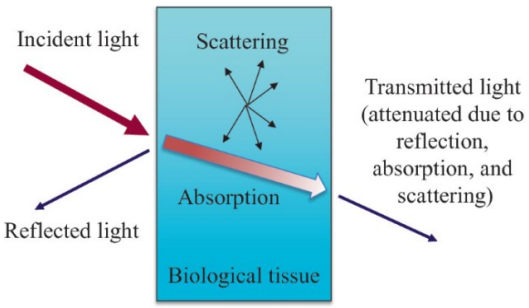

Fig 7.2:light and tissue

ISSN: 2278-4632
Vol-13, Issue-06, No.01,June : 2023

To establish a correlation between the NIR sensor readings and actual glucose concentrations, calibration is performed. A calibration dataset is collected, consisting of reference glucose values obtained through traditional invasive methods (e.g., blood samples) and corresponding NIR sensor readings. Mathematical algorithms are developed to map the sensor readings to glucose concentrations.Arduino serves as the central processing unit for acquiring and processing data from the NIR sensors. The Arduino is programmed to control the timing and intensity of the NIR light emission, as well as to capture the corresponding sensor readings. The acquired data is processed using signal processing techniques, such as filtering and noise reduction, to enhance the quality of the NIR signal.

Using the calibration algorithms and the processed NIR sensor readings, the Arduino estimates glucose concentrations. The calibration curve or mathematical model derived from the calibration dataset is applied to convert the sensor readings into meaningful glucose values.To enable wireless communication and remote monitoring, Bluetooth modules are integrated with Arduino. This allows the glucometer to transmit glucose measurements in real-time to external devices, such as smartphones or computers, for visualization and data analysis.

VIII. Project Workflow

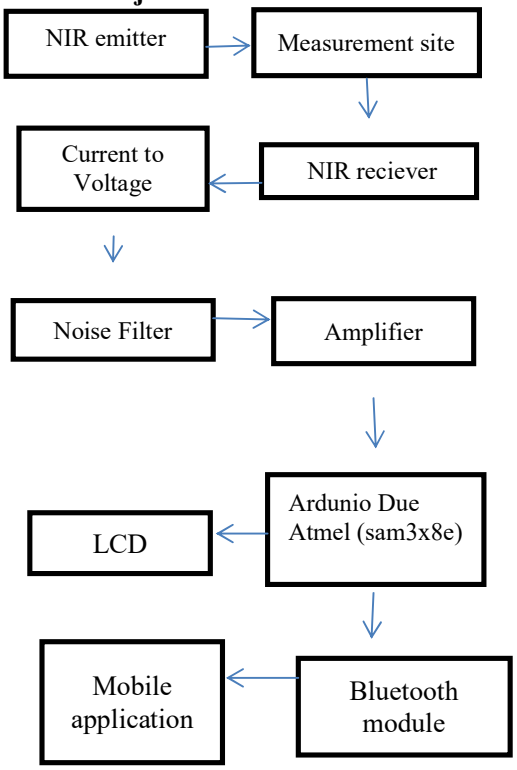

Fig.8.1 Flowchart

Explanation of Flow Chart:

The proposed methodology utilizes NIR optical technology for the non-invasive glucometer using Arduino. The system incorporates a NIR light source with a wavelength of 940 nm, which is ideal for measuring blood glucose concentration. The measurement process involves placing the NIR transmitter and receiver on opposite sides of the fingertip. As NIR light passes through the fingertip, it interacts with glucose molecules present in the blood. This interaction results in some of the NIR light being absorbed, while the remaining light is transmitted through the fingertip. The light detector detects the transmitted signal, and the output current is converted to a voltage signal, which is then filtered and amplified. This amplified signal is then fed into the Arduino microcontroller. The Arduino processes the digital signal using quadratic regression analysis, enabling the prediction of

blood glucose levels. The calculated glucose value is displayed on an LCD screen for easy readability. Additionally, the blood glucose value is transmitted to a mobile application via Bluetooth, allowing users to conveniently monitor their glucose levels on their smartphones.

IX. Results and Outputs

The results and outputs of a non-invasive glucometer using Arduino and NIR sensor include:
Thesystem provides real-time measurements of blood glucose levels using the NIR sensor and Arduino. These measurements are obtained non-invasively, without the need for fingerstick testing, making it a more convenient and painless option for individuals with diabetes. The measured glucose value is displayed on an LCD screen connected to the Arduino. Users can easily read and track their glucose levels directly from the glucometer device.The glucometer is equipped with Bluetooth capabilities, allowing it to transmit the glucose measurements wirelessly to external devices such as smartphones or computers. This enables remote monitoring and data analysis, providing users with the flexibility to access and manage their glucose data from anywhere.

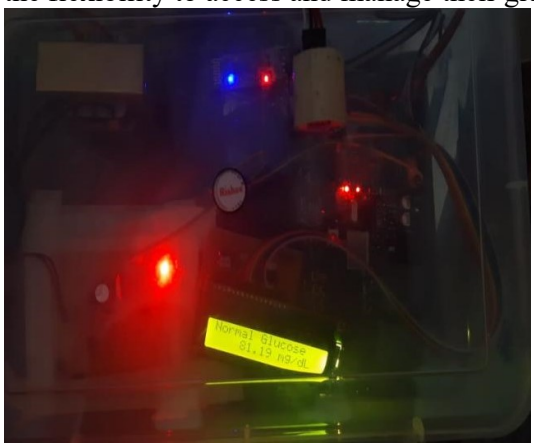

Fig 9.1: Output of the Project

X. Conclusion

The project has successfully developed and integrated the functions of all hardware components, strategically placing each module to ensure optimal device performance. The implementation of the project was achieved with the utilization of advanced integrated circuits, showcasing the project's adaptability to emerging technologies.In comparison to the invasive glucose measurement method, which is painful, costly, inconvenient, and carries infection risks, this project presents a non-invasive alternative using an infrared LED. The glucose level detected by the light detector is displayed on both the LCD screen and a mobile application specially designed for this purpose. This portable and non-invasive blood glucose monitor offers an effective solution for individuals with diabetes to manage their healthcare. It can be utilized for blood sugar monitoring in various settings, including home and healthcare centers.

Acknowledgments

We would like to express our sincere gratitudeto Dr.Abhishek Choubey, Assistant Professor in the Department of Electronics and Communication Engineering at Sreenidhi Institute of Science and Technology, Ghatkesar, for providing us with valuable guidance and support throughout this major project. Her timely suggestions and encouragement were invaluable to our work.
We would like to express our gratitude to Dr. Shruti Bhargava, Dean-Innovation, Associate Professor, ECE Dep , Dr. S.P.V. Subba Rao, Head of the Department of ElectronicsandCommunication, Engineering, Dr.C V TOMMY, Executive Director and Dr. M. SHIVA REDDY, Principal at Sreenidhi Institute of Science and Technology, Ghatkesar, for his invaluable guidance and support during the completion of this project.

ISSN: 2278-4632
Vol-13, Issue-06, No.01,June : 2023

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