ARDUINO-BASED NON-INVASIVE BLOOD SUGAR ANALYZER INSTRUMENTATION SYSTEM

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ABSTRACT
Arduino-based Non-Invasive Blood Sugar Measurement Instrumentation System is a system designed to measure blood sugar levels without requiring blood samples, as in invasive methods. The system uses photodiodes and LEDs (Light Emitting Diodes) function as a measurement process using optical principles. Arduino as the base of the microcontroller to manage the sensor and measurement process, process the data from the sensor, and send it to the LCD for display. The testing and calibration of the device showed that the average error percentage was around 2.91%, indicating an excellent degree of accuracy in measuring sugar levels non-invasively, although there were slight deviations that were still within acceptable tolerances. By considering the average result of the percentage of error it can be concluded that this system is effective and reliable for blood sugar measurement without invasive.
Keywords: *Blood Sugar; microcontroller; photodiodes and led;*

INTRODUCTION

Blood sugar is a disease related to methobolic syndrome which is characterized by increased blood glucose levels or known as hyperglycemia. Hyperglycemia occurs when the body cannot produce enough insulin or when the body cannot use insulin effectively. Insulin is a hormone that helps regulate glucose levels in the blood. When blood glucose rises, it can lead to a variety of complications, especially if left untreated, such as damage to blood vessels, nerves, and other organs of the body. It is important for individuals with hyperglycemia or who are at risk of developing this condition to monitor their blood sugar levels regularly, maintain a healthy diet, and exercise regularly (Rammang, Nurhikmah and Reza, 2023).

Sugar or glucose present in our blood. In medical terms, it is referred to as blood glucose. Blood sugar is a simple type of sugar that is the main source of energy for the body's cells. Blood sugar levels are regulated by the hormone insulin produced by the pancreas. Blood sugar comes from the food we eat, and is the main source of energy for the body. In order to reach all cells in our body, this sugar is flowed through the blood vessels.

Sugar or glucose can be caused by 4 things, namely, wrong diet, frequent drinking or eating sugary foods, insulin hormone problems, and lack of sleep. Type 1 Diabetes A condition in which the pancreas does not produce insulin, which is necessary to regulate blood glucose levels. Type 2 Diabetes A condition in which the body does not use insulin effectively (insulin resistance) or does not produce enough insulin. This research focuses on blood sugar meters, namely an instrumentation system for non-invasive blood sugar level measuring devices based on arduino or without injuring the body.

Based on these problems, the author offers a solution to design an instrumentation system for an arduino-based non-invasive blood sugar level measuring device using the calculation of the concentration value of the solution and by refraction of the vibrating field of light waves by Photodiode and LED sensors and fingers as the object of the measuring medium and invasive method without injuring the patient. The light waves pass through the finger and are responded to by the photodiode sensor.

METHOD

Quantitative research methods. Quantitative research methods are research approaches that focus on collecting and analyzing data conducted by experimental research. By conducting experiments on control variables (inputs) to analyze the output produced.

RESULT AND DISCUSSION

This chapter discusses the planning and development of tools. After the development stage is completed, testing of the developed tools is carried out.

Result

- **Design**

Block Diagram Design

Blog diagrams are graphical representations of a system or process that illustrate the relationships between various components or parts of a system.
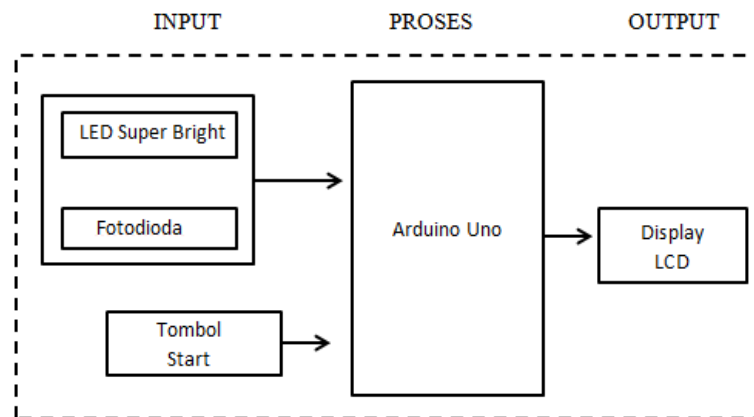
**Figure 1.** Block Diagram

Tool Planning

tool or schematic design, this design is formed by combining an Arduino uno, an LCD and a module connected with a Photodiode and Led. Photodiodes are used to find out what blood sugar levels are in the body. The photodiode reads the tilapia assisted by leds.
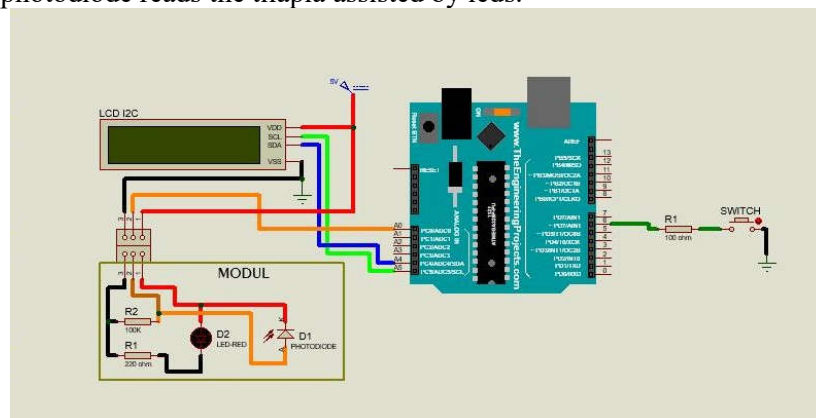
Figure 2. Schematic Networks

Flowchat diagram

A flowchart is a graphical tool used to illustrate the steps or processes in a system. Flowcharts make it easy to visualize the entire process, thus aiding in understanding the workflow from start to finish.
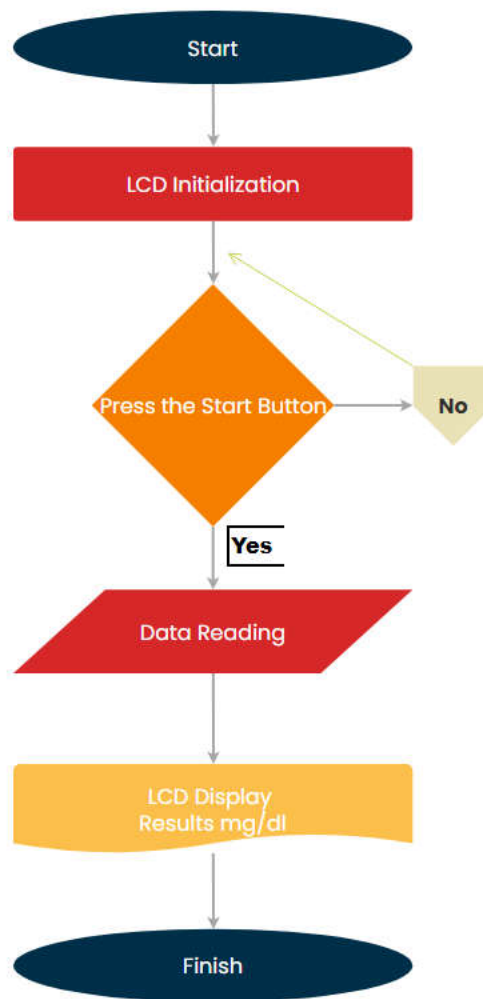
Figure 3. Flowchat (Diagram Flow)

- **Hardware Assembly**
  Led and Photodediode Circuits
  Led and Photodeoda as the main components, namely :
  1. LED:
     Serves as a light source.
     The light produced is usually at a certain wavelength that can penetrate the skin and body tissues.
     Infrared or red wavelengths are often used because they have good penetration into body tissues.
  2. Photodiode:
     Functions as a light sensor.
     Detects the intensity of light that has passed through or reflected by body tissues.
     The output of the photodiode is an electrical signal that is proportional to the intensity of the light received.

Figure 4. Led and Photodediode

I2C LCD Network
An I2C LCD is an LCD module that uses an I2C (Inter-Integrated Circuit) communication interface to communicate with a microcontroller such as an Arduino.


Figure 5. I2C LCD Network

Discussion

Testing and Measurement Results
The test was carried out by inserting a finger between the photodiode and the led. The sensor will read the value and then it will be displayed on the LCD.

Table 1. Testing and Measurement Results

No	Measurement data (mg/dL)	Actual blood sugar (mg/dL)
1.	82,94	84
2.	81,20	83
3.	139,59	140
4.	109,57	112
5.	264,21	264
6.	84,14	85
7.	80,69	86
8.	287,5	290
9.	85,3	89
10.	111,2	114
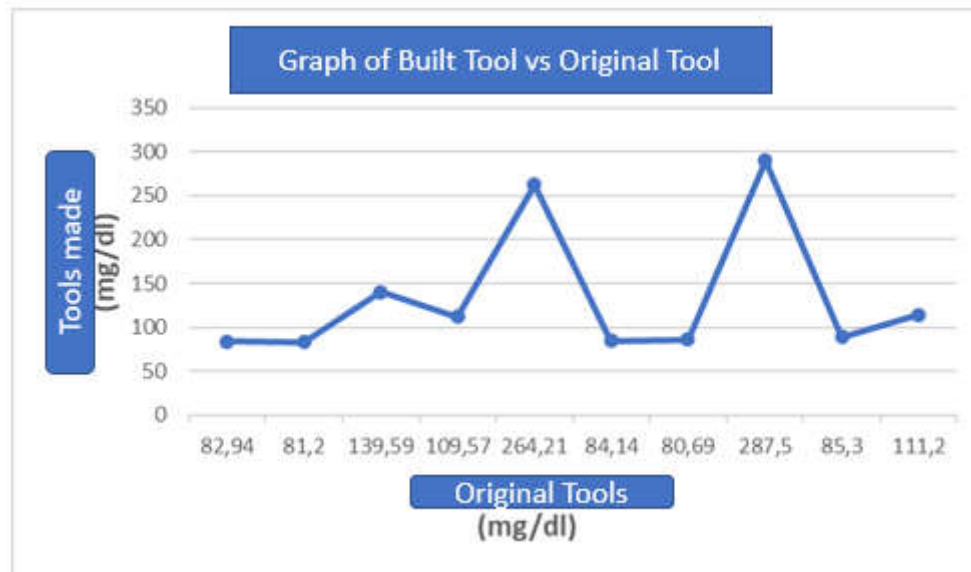
Figure 6. Comparison of Crafted Tool Graphs with Original Tools

CONCLUSIONS

From the results of the research that has been carried out, several conclusions can be drawn. The average percentage of current error of 2.92% shows that the tool has a good level of accuracy in measuring blood sugar values non-invasively. This fairly small error indicates that the reading of the value from the instrument is very close to that of the invasive measuring instrument. Measurement Accuracy: This measuring instrument system shows an average accuracy of 97.09%. This shows that the tool has a high level of precision in measuring blood sugar levels compared to the actual value measured by conventional methods. Stability and Consistency: The results obtained show that this tool has quite good stability and consistency in non-invasive blood sugar level measurement. The low relative error and high accuracy show that this tool can be used on a daily basis and with ever-evolving technology.

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