GLUCare

An Advanced Non-Invasive Glucose Monitoring System using NIR Spectroscopy

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Problem Definition

Non-invasive glucose measurement using Near-Infrared (NIR) spectroscopy offers a promising alternative to traditional methods, but commercialization has been hindered by accuracy and precision challenges.

This project aims to address these issues by integrating clinical factors that account for physiological differences, improving the accuracy and reliability of NIR-based detection, and paving the way for successful commercialization.

Project Scope & Objectives

The scope of this project is to develop an accurate, reliable, and affordable non-invasive glucose monitoring sensor that is easy to use and compatible with existing diabetes management systems.

Additionally , we will create a website where patients and doctors can log in to track glucose levels and schedule appointments.

1. To analyze and compare existing state of the art technologies for glucose monitoring.

2. To design and implement a non-invasive device to monitor Blood Glucose level using Machine Learning.

3. To create the test data and validate the performance of the device by comparing with clinical invasive techniques.

4. To design and develop a web application/app to display the results.

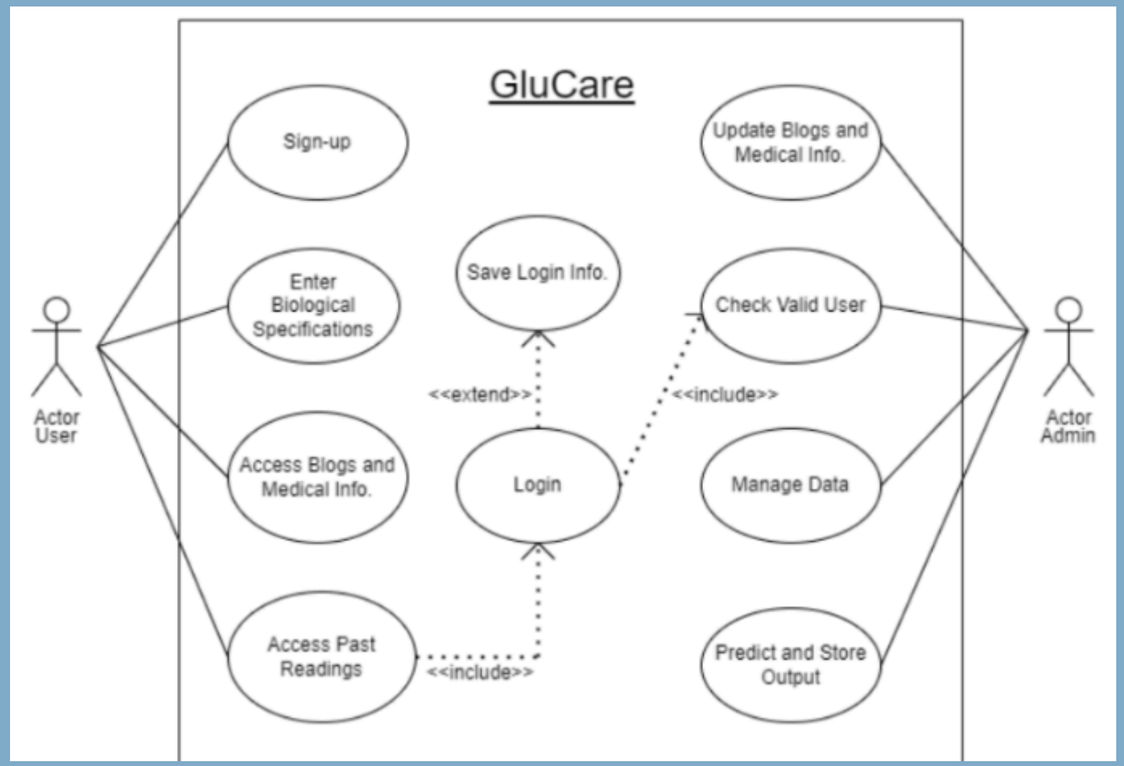
Project Analysis

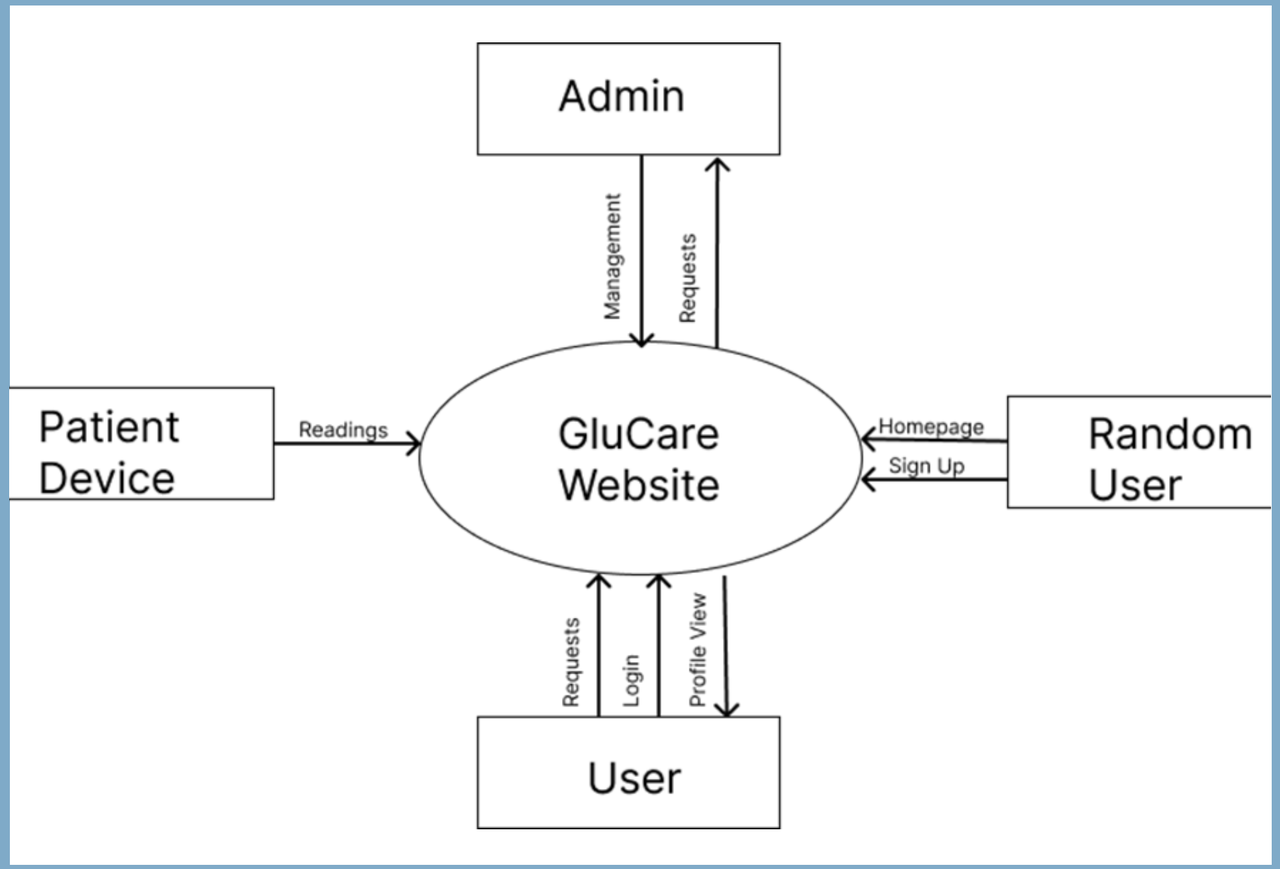
Non-invasive way of Blood Glucose Level Measuring system.

Use of NIR Spectroscopy for glucose measuring to achieve more precision as compared to other spectroscopic methods.

Developing a website as a comprehensive solution for the patients to easily track their glucose level in real time and also generate reports containing detailed analysis of their data that is reliable.

UML DIAGRAMS

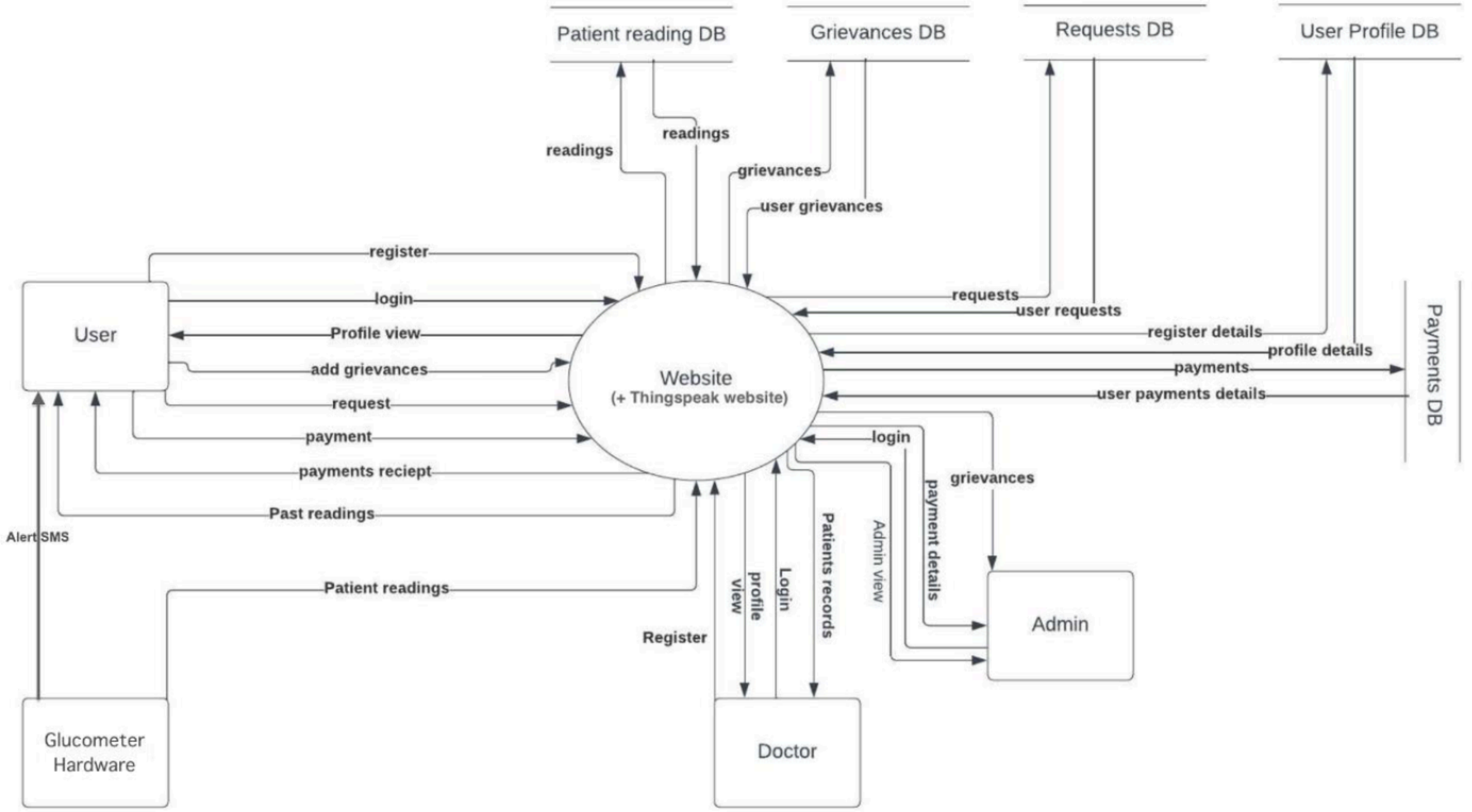




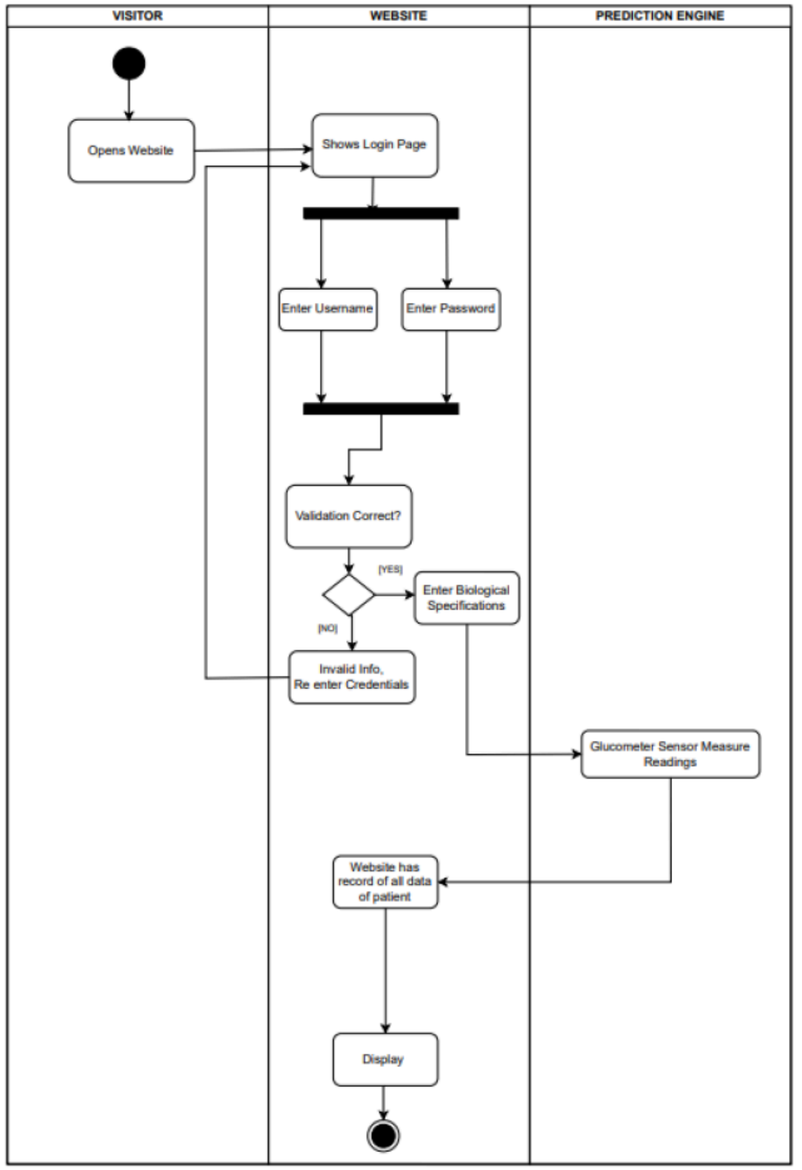
USE CASE DIAGRAM

DFD LEVEL 0

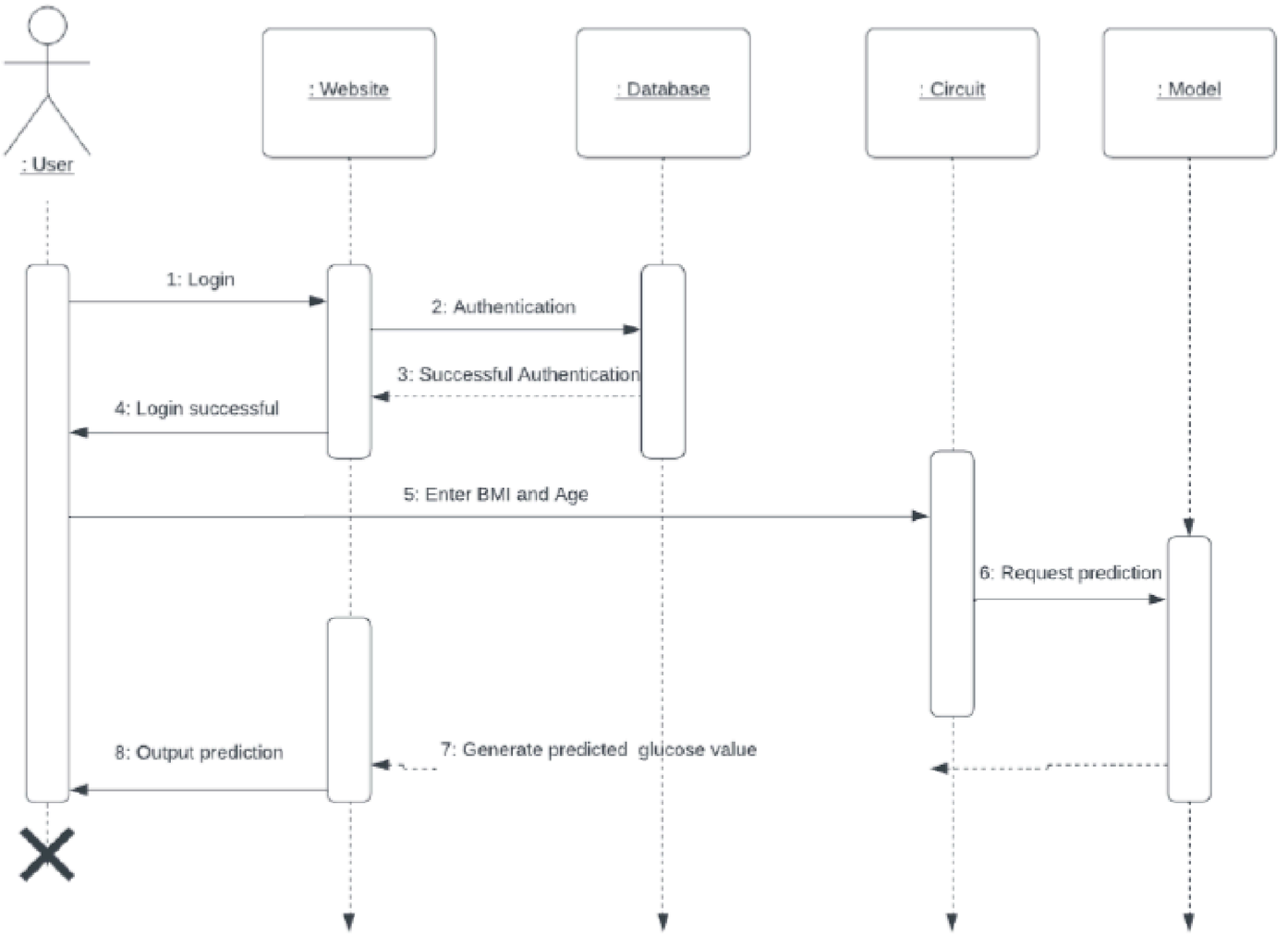
DFD 1


Patient reading DB
Grievances DB
Requests DB
User Profile DB
Payments DB
readings
readings
grievances
user grievances
register
login
Profile view
add grievances
request
payment
payments reciept
Past readings
Alert SMS
User
Website
(+ Thingspeak website)
requests
user requests
register details
profile details
payments
user payments details
login
grievances
payment details
Admin view
Patients records
Login
profile view
Register
Patient readings
Admin
Glucometer Hardware
Doctor

Activity Diagram



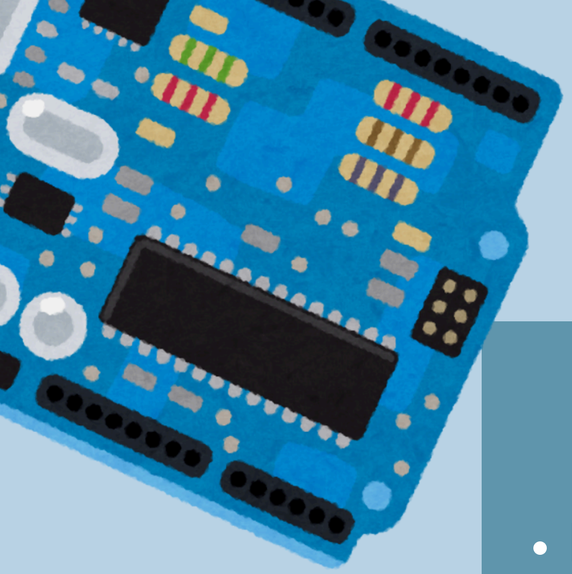
Sequence Diagram



Literature Survey

Research Paper	Tools/Technology	Findings
Non-Invasive Blood Glucose Monitoring Technology	NIRS, Electrochemical Sensors, Ultrasound, Thermal Sensors, Multispectral and Hyperspectral Imaging	NIR spectroscopy :non-invasive alternative to traditional blood glucose testing. Technological Advancements: Real-time glucose measurements without the need for blood samples, improving patient compliance and ease of use.
Non-invasive methods of glucose measurement: current status and future perspectives	Support vector regression (SVR), Principal component regression (PCR) , and Artificial neural network (ANN)	This paper examines non-invasive blood glucose monitoring as a means of improving diabetes care. It discusses the implications of tested devices and highlights the shortcomings of existing approaches.
Wearable-band type visible-near infrared optical biosensor for non-invasive blood glucose monitoring	NIR Sensor, Digital wavelet transform	A wearable blood glucose sensor using visible-near infrared spectroscopy shows promise with a correlation coefficient of 0.86 and a prediction error of 6.16 mg/dl in trials with 12 volunteers.

Detailed Design



TOOLS USED

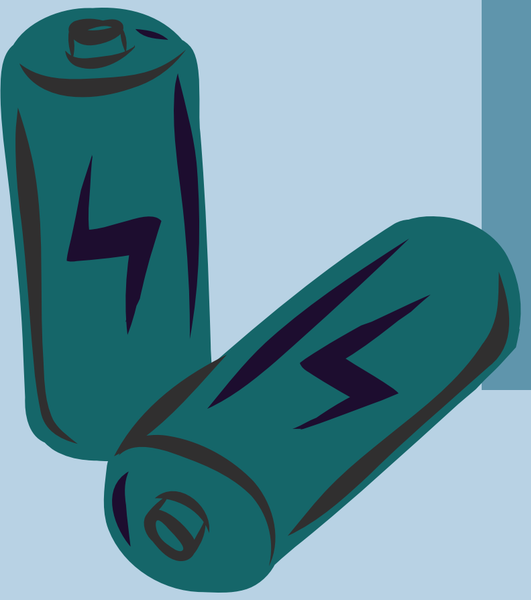
- NIR Sensor(TCRT5000)
- Arduino UNO
- Raspberry pi
- Wifi Board ESP8266
- LCD
- Buzzer and Button
- Lithium Battery
- Connectors
- Cables

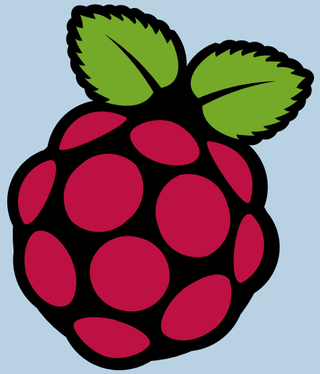
PLATFORMS

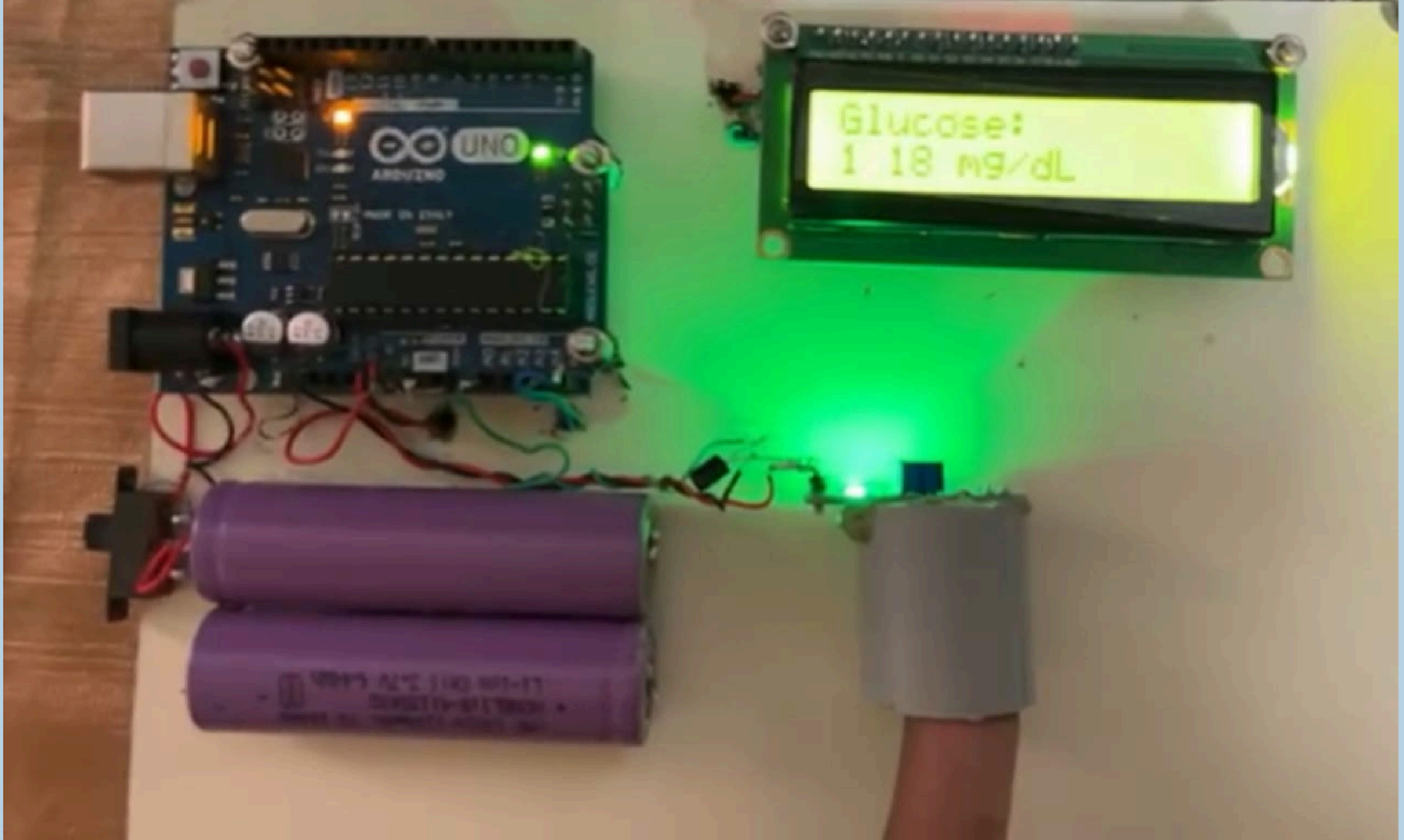
- Wokwi Simulator
- Tinkercad
- Arduino IDE

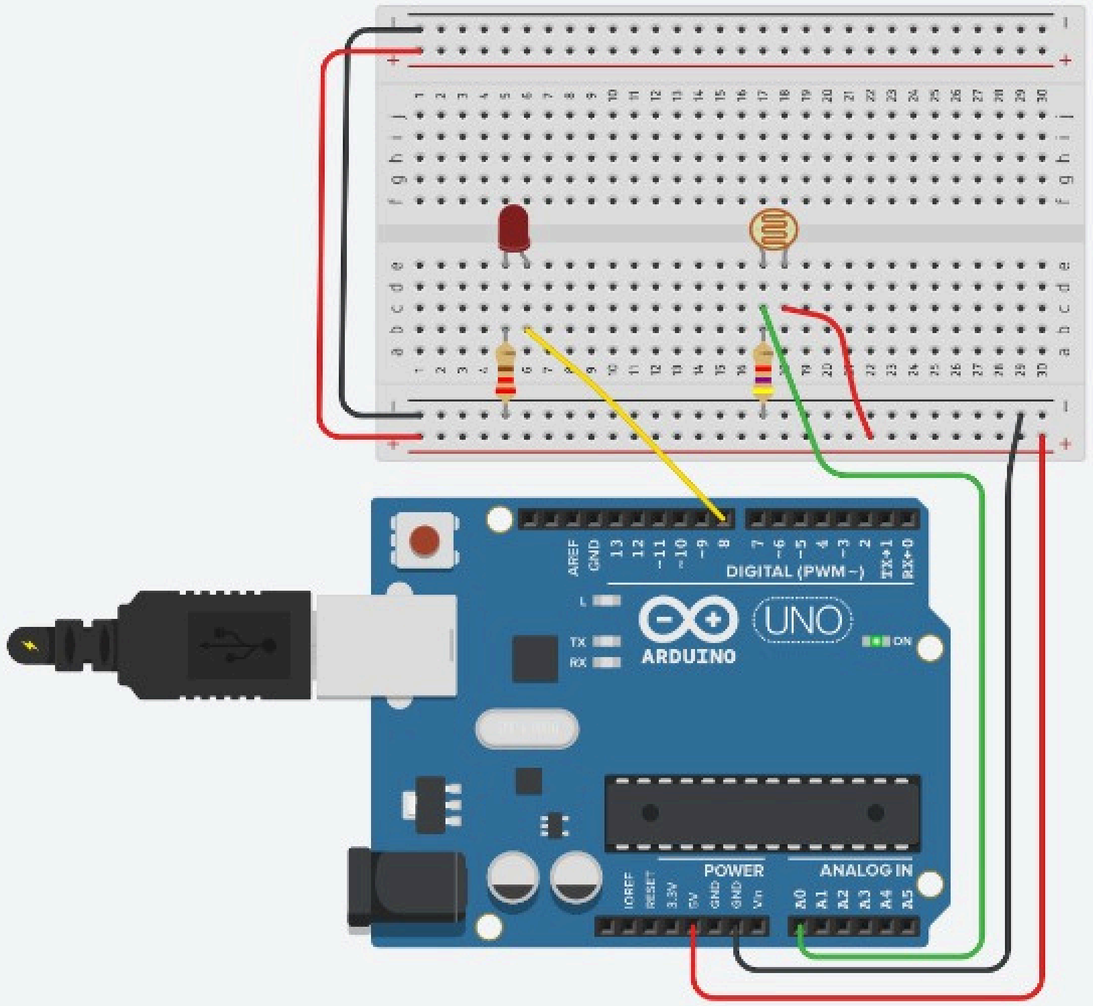
TECH-STACK

- **React.js**
- Firebase
- MongoDB






UNO
ARDUINO
Glucose:
1 18 mg/dL



1 (Arduino Uno R3)

```ino
int ledPin = 8;
int ldrPin = A0;
int ldrValue = 0;

void setup() {
  pinMode(ledPin, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  ldrValue = analogRead(ldrPin);
  Serial.println(ldrValue);

  // Calculate the glucose level using the regression formula
  int glucoseLevel = ((0.000009) * (ldrValue) * (ldrValue)) + (0.

  // Display the glucose level in the Serial Monitor
  Serial.print("Glucose Level: ");
  Serial.println(glucoseLevel);

  // Use the glucose level to control the LED
  if (glucoseLevel > 120) {  // Example threshold value for high
    digitalWrite(ledPin, HIGH);
  } else {
```

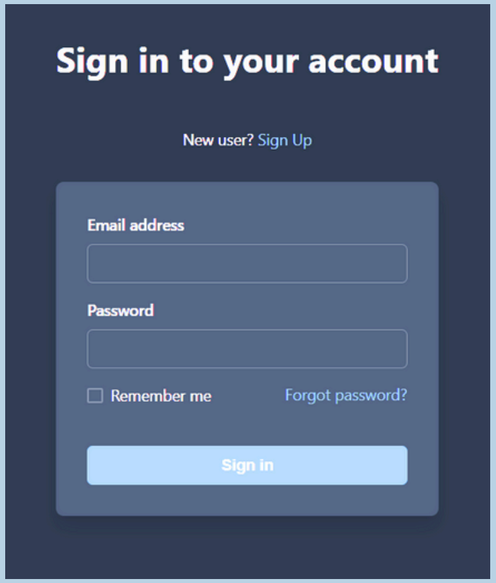
Serial Monitor

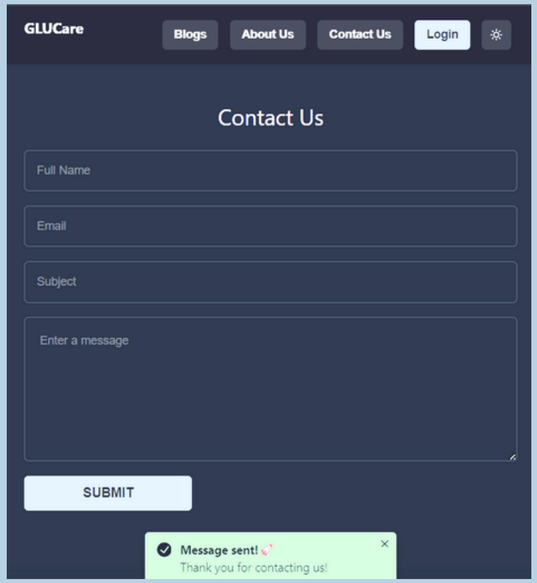
```
389
Glucose Level: 120
389
Glucose Level: 120
389
Glucose Level: 120
```

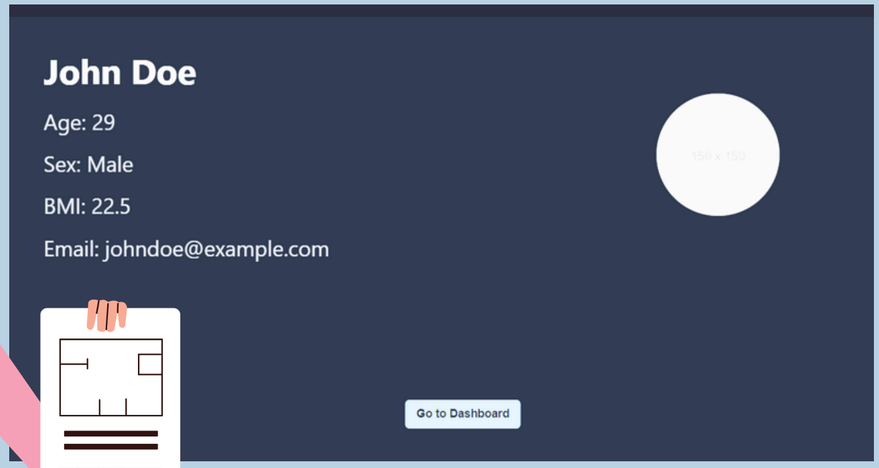
Send Clear

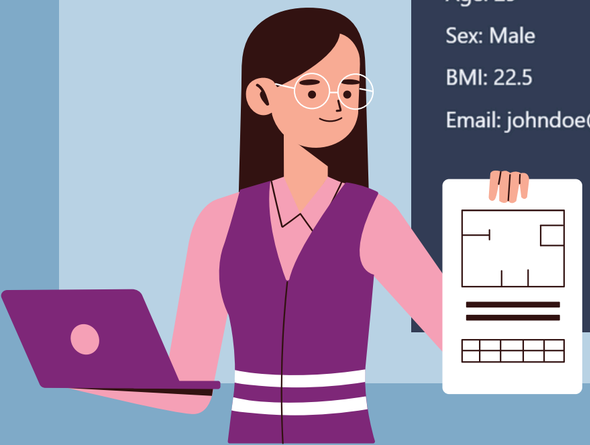
Website UI Design

Website Link

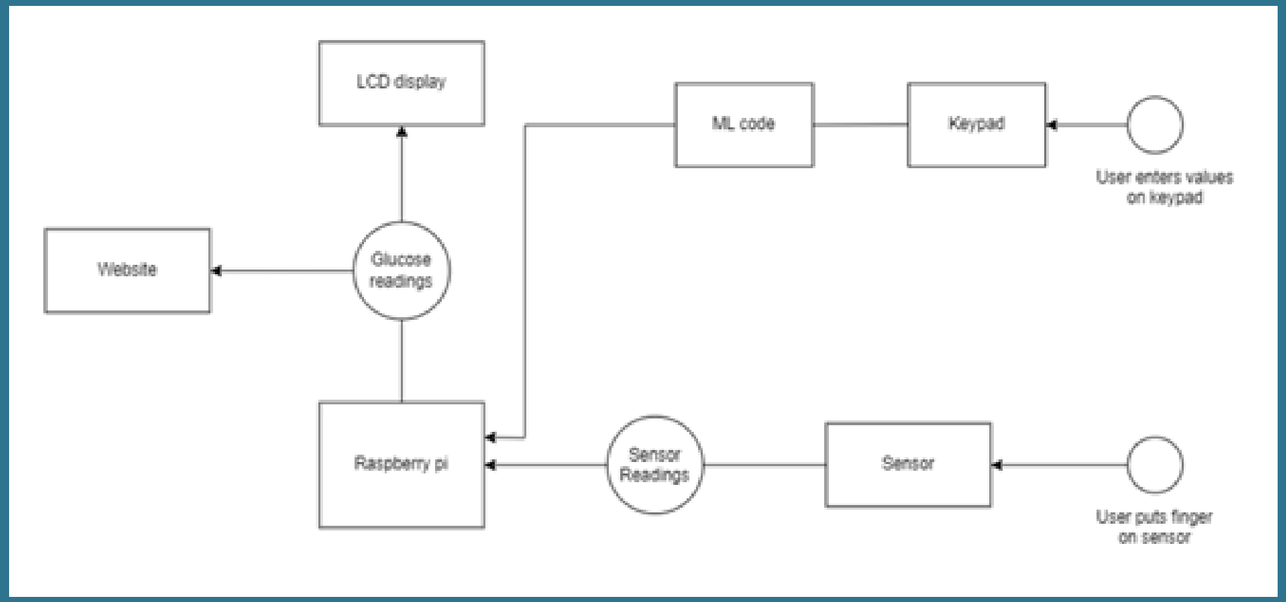




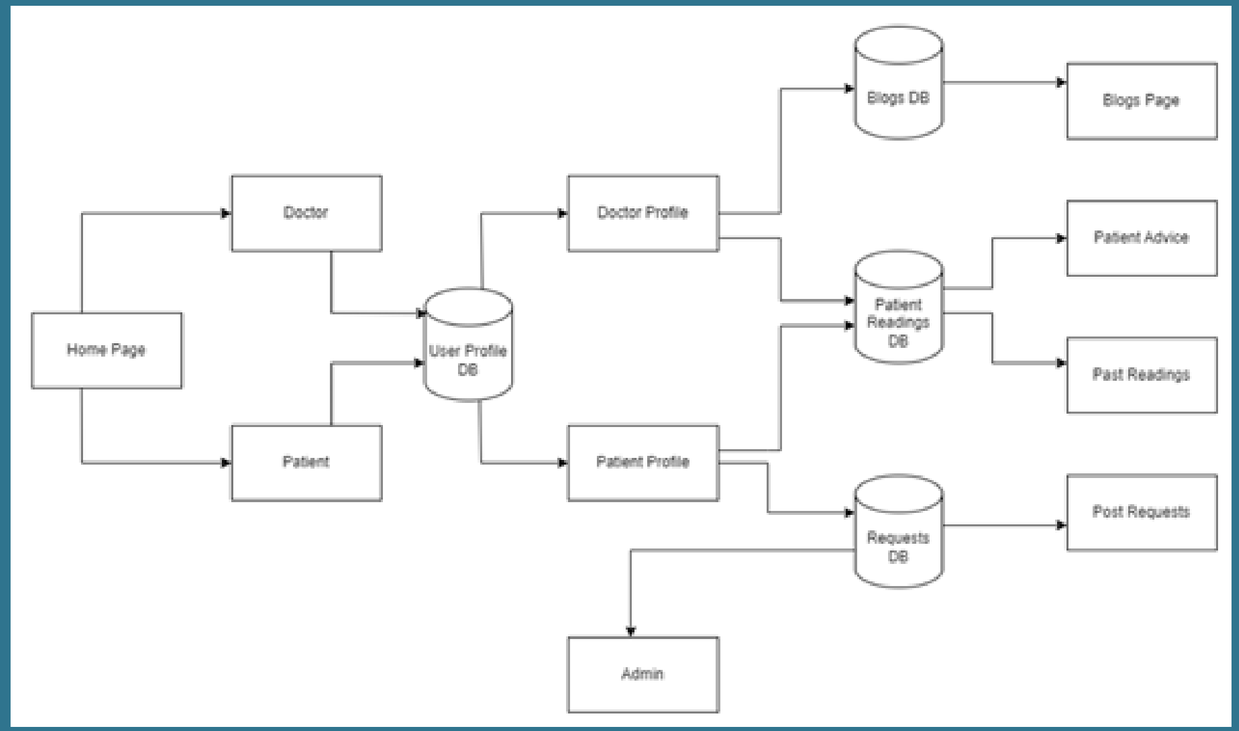




Architecture Design



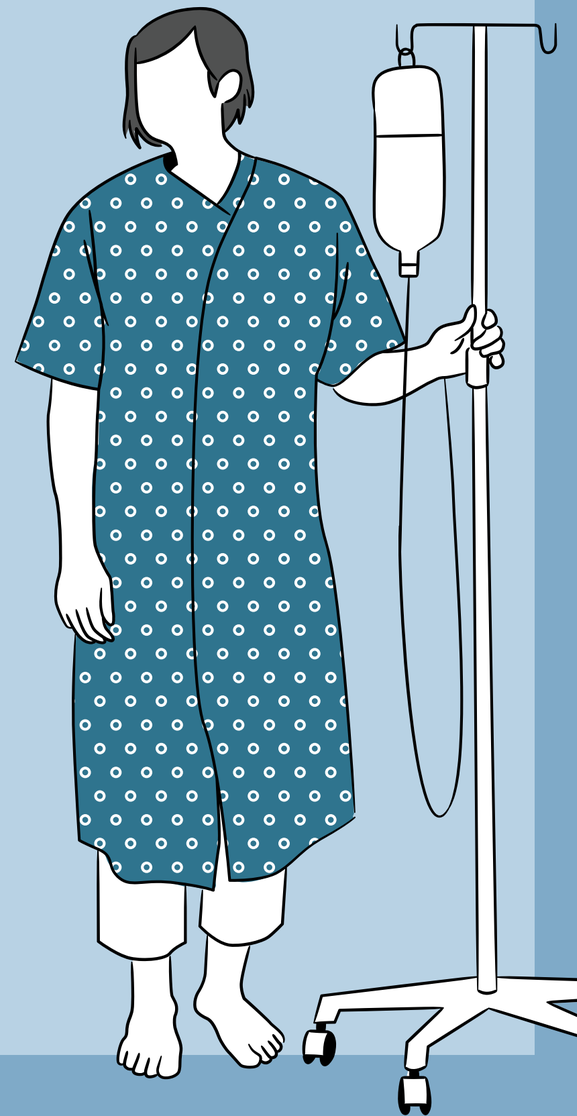
Component Diagram



Website Architecture

Cost Analysis

S. No.	COMPONENT	COST	ISSUED
1	NIR Sensor	1600	No
2	Raspberry Pi	5500	Yes
3	Arduino UNO	1000	Yes
4	LCD	300	Yes
5	Wifi Board ESP8266	350	Yes
6	Lithium Battery	300	No
7	Buzzer and Button	220	Yes
8	SD Card 32GB	220	Yes
9	Connectors and Cables	200	No
	Total Cost	9700	2100



Project Outcomes

01. To develop an accurate and reliable non-invasive blood sugar level monitoring device.

02. Validate the proposed system using current testing methods across different demographics.

03. Develop a user friendly web application which will track user's blood sugar level

Role/ Contributions of Individual Team Members

Research Work

Pia
Anupriya
Nitleen
Stuti

Design and study of hardware

Nitleen
Pia
Stuti

Model Training

Stuti
Nitleen
Pia
Riddhi

Web application developement

Anupriya
Nitleen
Riddhi
Pia

Integration of hardware & software

Nitleen
Pia
Anupriya
Riddhi
Stuti

Testing

Pia
Anupriya
Nitleen
Stuti

Current Progress

Future Work Plan

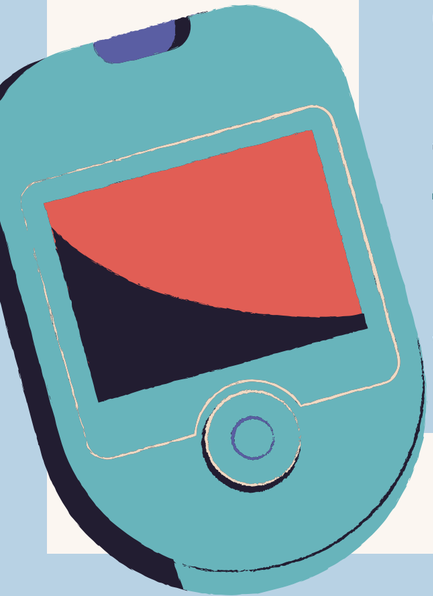
1. **Improve Circuit with Machine Learning:** To enhance circuit accuracy using models like Random Forest, Decision Tree, etc.

2. **Data Creation:** Creation of Dataset using designed hardware by collecting samples from people of different physiques.

3. **HbA1c:** Focus on calculating HbA1c with the help of continuous monitoring.

4. **Machine Learning for Validation:** To apply machine learning for circuit validation and error analysis.

5. **Integrate Data on Website:** To update user profiles with relevant data on the website.



References

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https://diabetesatlas.org/idfawp/resource-files/2021/07/IDF_Atlas_10th_Edition_2021.pdf

On the use of fiber lasers in non-invasive blood glucose monitoring
https://www.sciencedirect.com/science/article/pii/S106852002200050

Non-Invasive Methods of Glucose Measurement: Current Status and Future Perspectives
https://www.researchgate.net/publication/221892032_Non-Invasive_Methods_of_Glucose_Measurement_Current_Status_and_Future_Perspectives

Wearable-band type visible-near infrared optical biosensor for non-invasive blood glucose monitoring
https://www.semanticscholar.org/paper/Wearable-band-type-visible-near-infrared-optical-Rachim-Chung/eebf89973bc64fcfcdb3dab1220864f918e0810f

Thank you very much!