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Level-Up Insulin

An Intelligent Closed-Loop Insulin Delivery System

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24AIM113 & **24AIM114**

Introduction to NN, CNN and GNN
Analog System Design

Faculty In-Charge – Dr. Snigdhatanu Acharya, Dr. Amrutha V

PRESENTATION LAYOUT

- Problem Statement
- Objectives
- Concept Block Diagram
- Prototype Design
- Progress so far
- Hardware related to prototype
- Neural Network model from readings of prototype I
- Future Goals
- Timeline

PROBLEM STATEMENT

Current insulin delivery systems often depend on **manual monitoring** and **administration**, causing challenges in achieving optimal blood glucose control for individuals with diabetes.

How can we make insulin injection **automated** as soon as glucose levels rise??

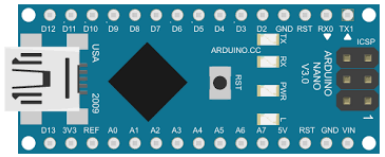
PROJECT GOALS

1. To provide an enhanced and smart **non-invasive Continuous Glucose Monitoring** (CGM) system and an automated insulin pump.
2. To develop an algorithm to **calibrate insulin dosage** based on live glucose monitoring as well as bolus and basal insulin.
3. To use better CGM sensor and enhancing its accuracy using **deep learning** techniques.
4. To incorporate RF transmitter and receiver for connecting CGM and insulin pump to provide **compactness and portability**.
5. To introduce a **safety system** (buzzer/haptic) for alerting in case of extreme hypoglycemia or hyperglycemia

CONCEPT BLOCK DIAGRAM

Power Source
7.4V Li-Po

Arduino Nano



RF Transmitter
433 MHz

RF Receiver
433 MHz

ESP32

Safety System
Buzzer/Haptics

Interface
OLED/LED

Power Source
9V Li-Ion

Insulin Pump
Motor + Syringe

Insulin Reservoir

Relay Module

Infusion Set

(Patient)
Type 1 Diabetes

Regular Intervals

AS7263
NIR Sensor

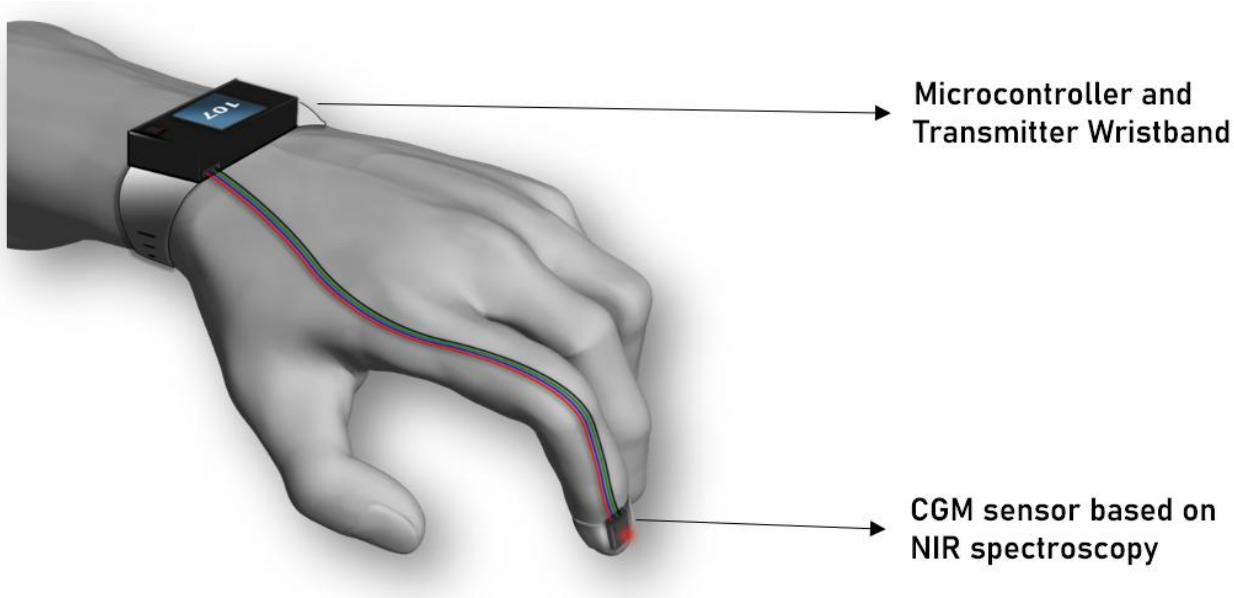
NIR Intensity

CGM

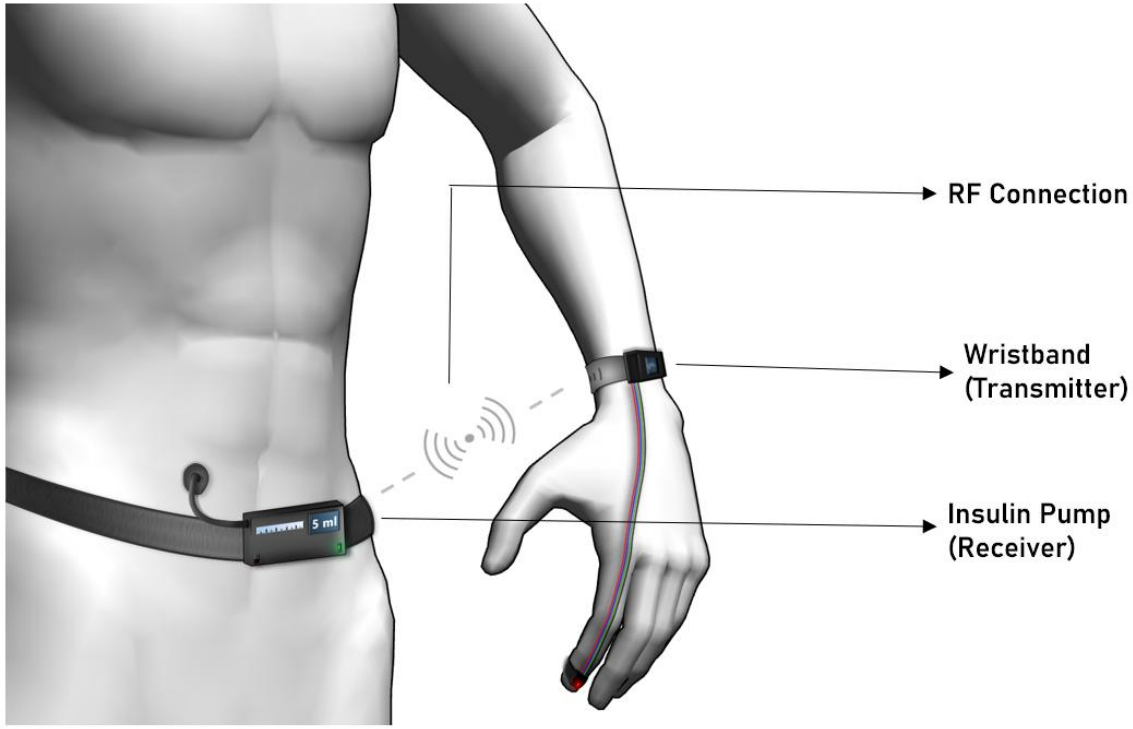
INSULIN PUMP

PROTOTYPE DESIGN

CGM



Insulin Pump



The **CGM** and **Insulin Pump** would be two separate devices integrated seamlessly through radio technology, as opposed to our previous design.

PROGRESS SO FAR

PROTOTYPE I

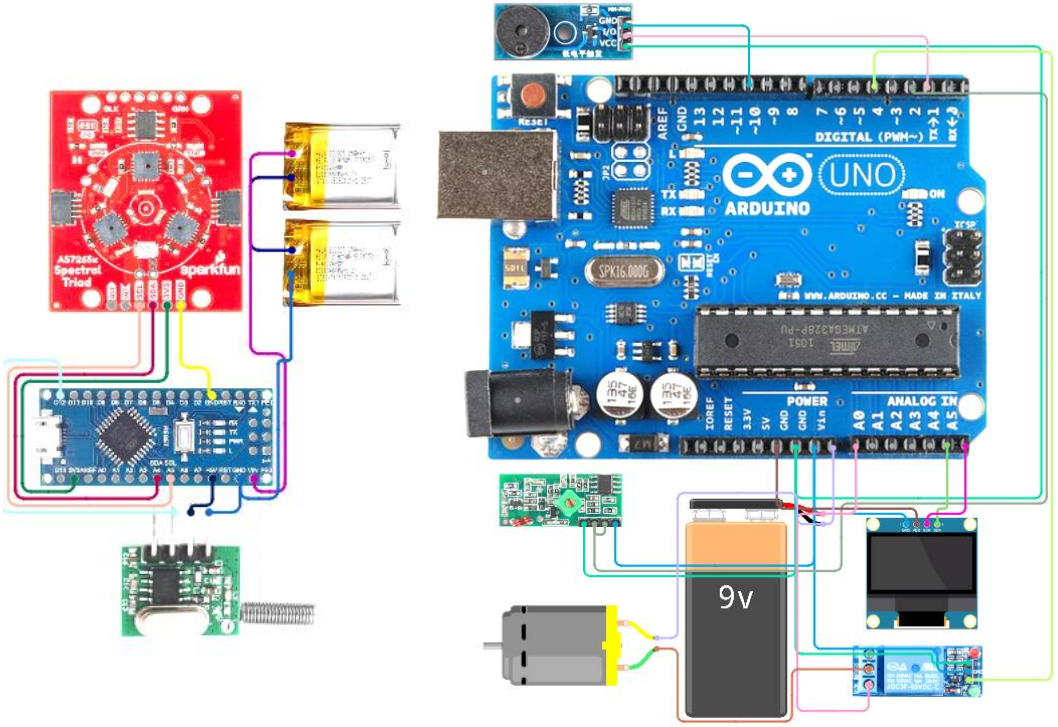
- Created dataset using **1123 readings** taken from prototype I.
- **Inputs taken:**
  (a) BPM
  (b) SpO2
- **Output values:**
  (a) Blood glucose
- Made a neural network based on collected data.

PROTOTYPE II

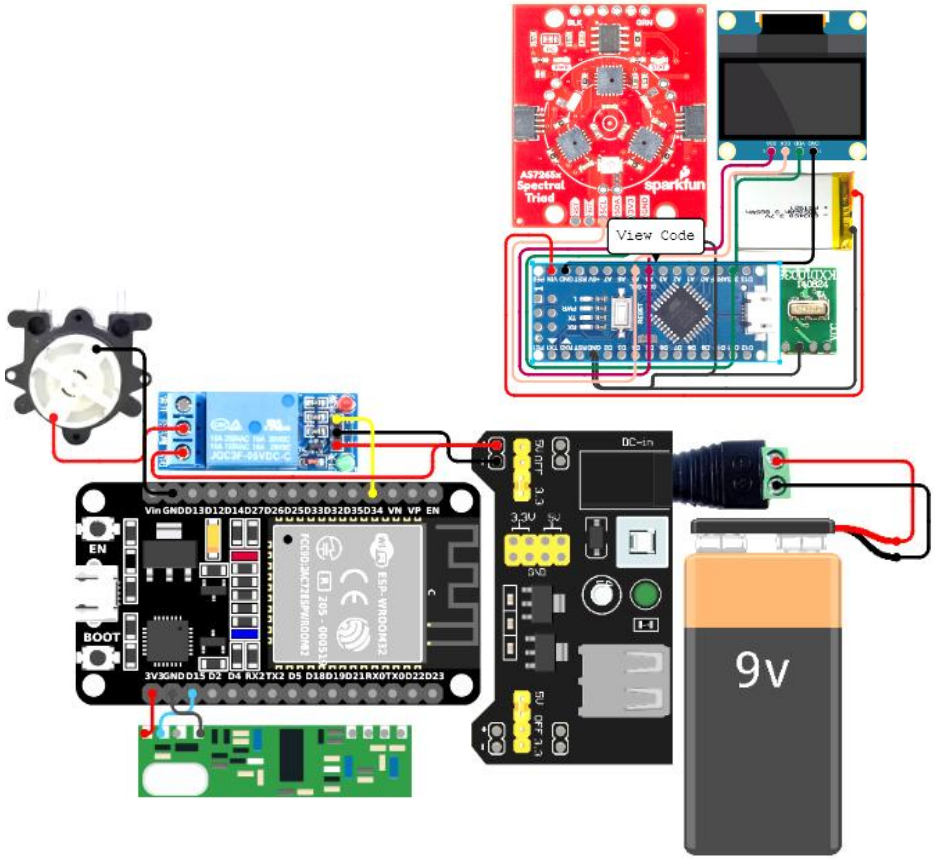
- Insulin **infusion pump** has been designed.
- Methodology has been deduced for converting intensity values from sensor to glucose values.
- **RF transmission** mechanism has been implemented.

HARDWARE RELATED TO PROTOTYPE

Previous Design



New Design



PROBLEMS FACED & SOLUTIONS DERIVED

1

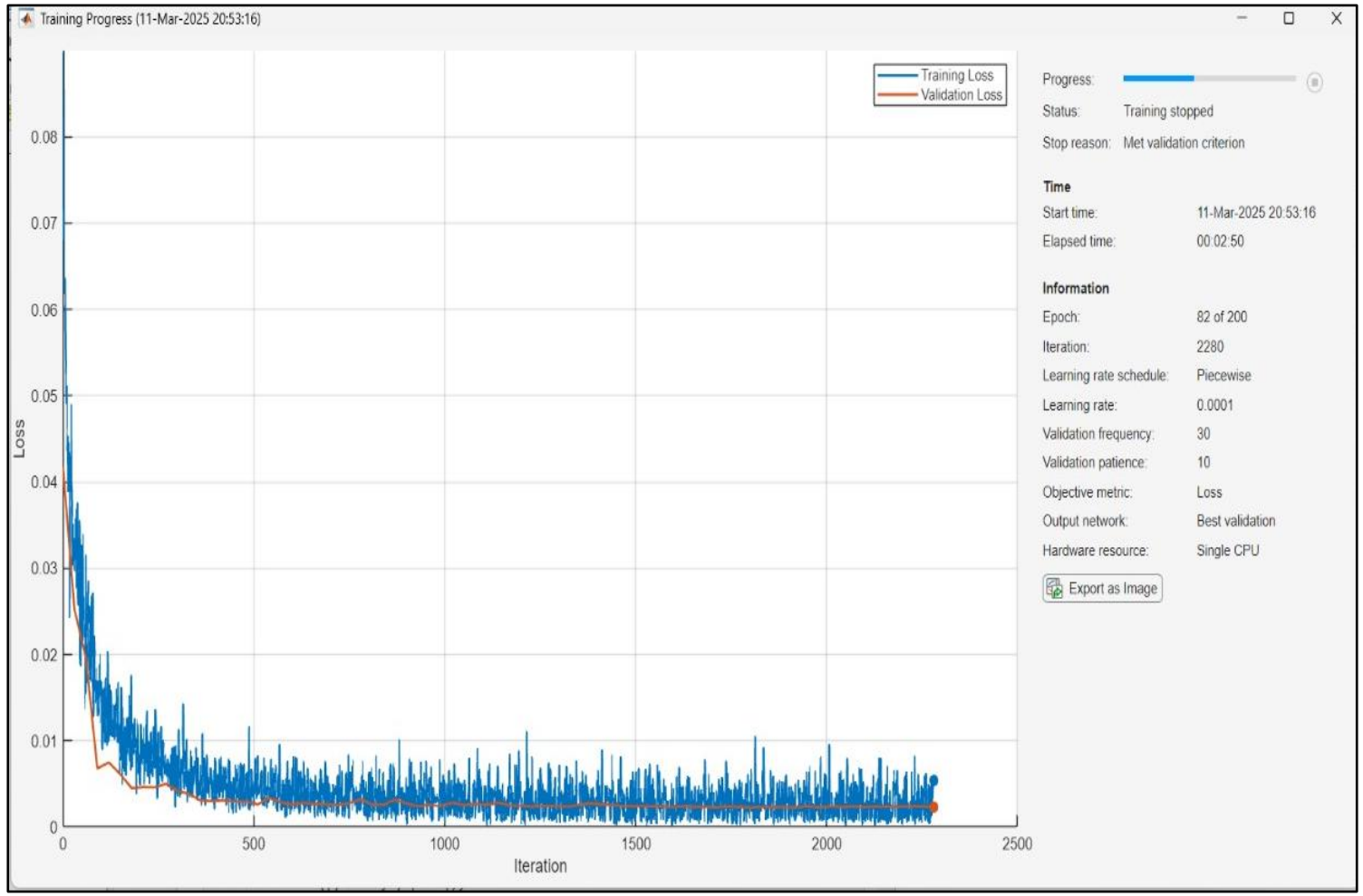
Poor accuracy with a vanilla Neural Network architecture	• Since a simple NN architecture was not working out, we went with a more complex architecture consisting of 4 fully connected layers and ReLU activation. • Z-Score normalization gave us a poor accuracy (~54%) After re-tuning the model, we found that Min-Max normalization gave us a better accuracy of 97.09%

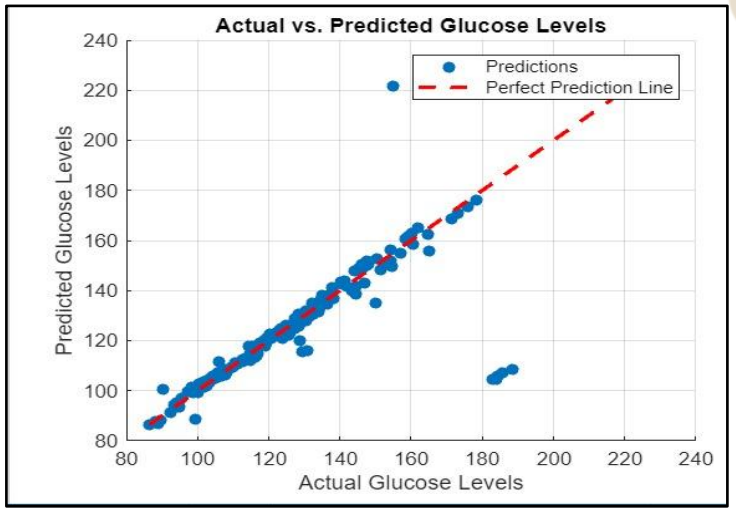
2

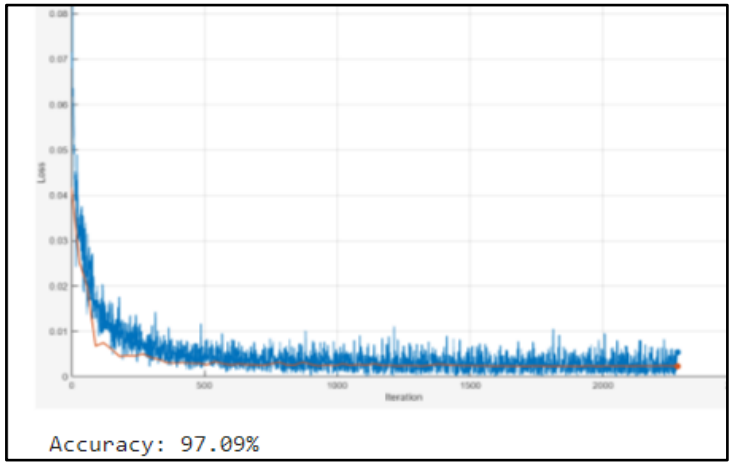
Low RAM on Arduino Uno and Nano boards (32KB)	• If we run the SSD1306 OLED Display on full resolution (128 x 64), there is not enough RAM left to load the RadioHead library. For now, it is running on half its maximum resolution (128 x 32). • This also prompted us the idea of integrating an Android App interface with the model, which is one more reason why we are using ESP32.

NN MODEL RESULTS

From Prototype 1



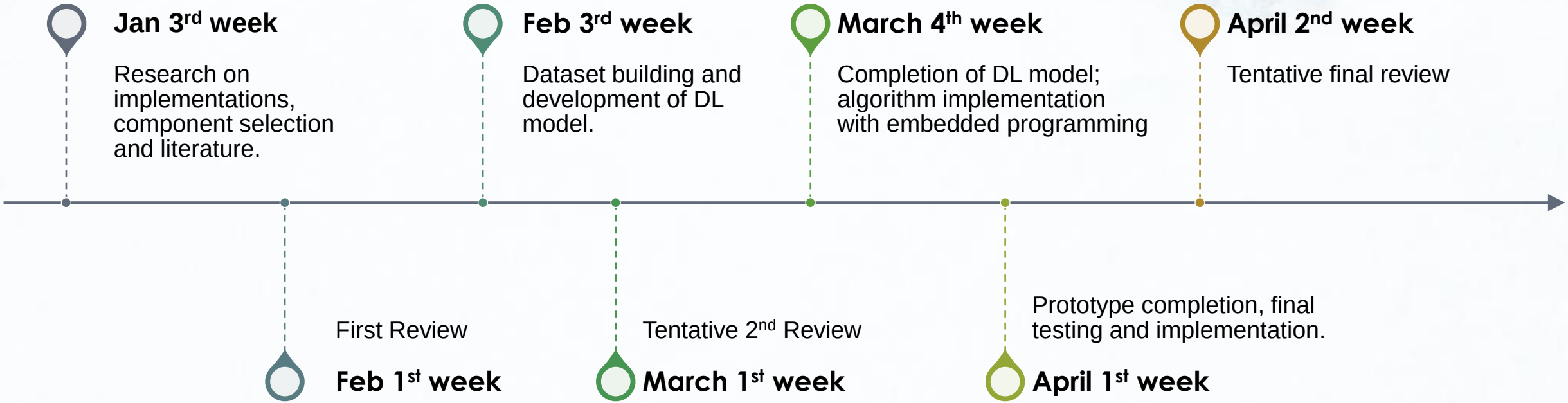




FUTURE GOALS

- ❑ To take experimental readings from NIR sensor of prototype II
- ❑ To make the neural network from the readings of prototype II
- ❑ To set up a comparison between the values of glucose from NN model of both the prototypes
- ❑ To achieve portability and compactness of the model in the final design

PROPOSED TIMELINE



Thank You