BurnSync

Your Personal Workout Assistant

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Motivation & Introduction

“Working Out Everyday ”

Nowadays people put more emphasis on health.
Exercise is the key to maintain well-being.

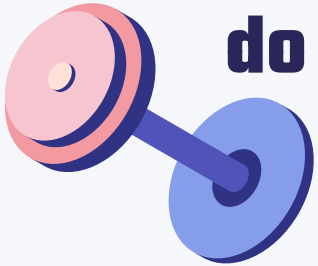
31%

Adults

80%

Adolescents

do not meet the recommended levels of physical activity



Reference: https://www.who.int/news-room/fact-sheets/detail/physical-activity

3Ls of Modern People

Lack of Time

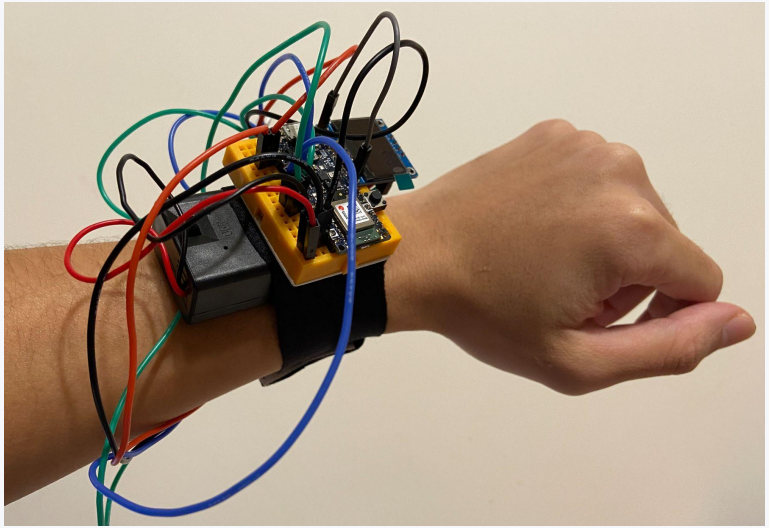
- Busy schedule
- Leisure activities

Lack of Money

- Sports equipment
- Renting venues

Lack of Motivation

- Fatigue
- Limited access to facilities
- Absence of immediate rewards



BurnSync:
Your Personal Workout Assistant

BurnSync

Convenient

- Highly connected
- User-friendly
- Time-efficient
- Accessible anywhere

Cheap

- 500 NTD↓ (excluding the Arduino Nano board)
- Cheaper for mass production

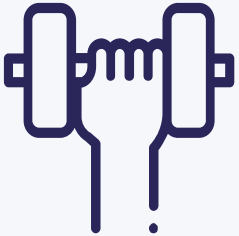
Achievement

- Personal records
- A sense of accomplishment

Functions

Detect Heart Rate

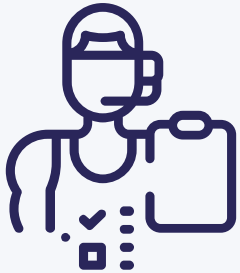
Exercise Classification



Sets/Repetitions Recording

Calories Estimation

Fitness Recommendation



02

Video Demo

AI Recommendation

Sit-ups

Push-ups

Squats

Dumbbells

Heart Rate Detection

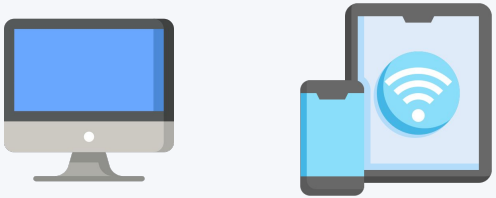
Personal Records

03

System Architecture

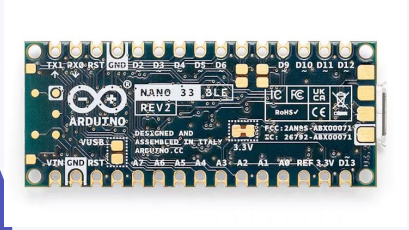
System Architecture

Personal Device
(Laptop / Phone / Tablet)



BLE

Arduino Nano 33 BLE Sense Rev2
(BurnSync Device)



Internet

Cloud Server

Vercel

API

Gemini Server
(Google LLM Model)

Gemini

Internet

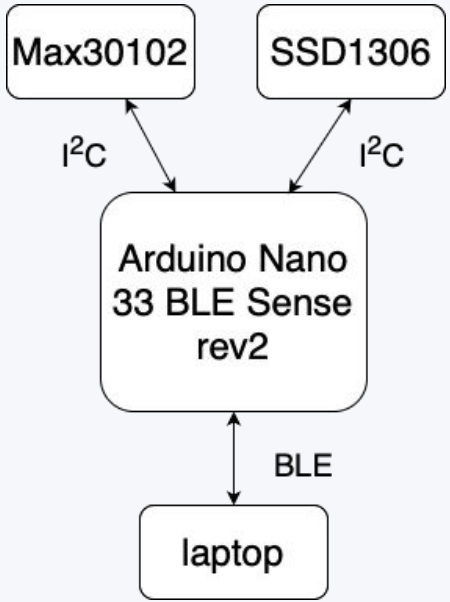
Database Server

Firebase

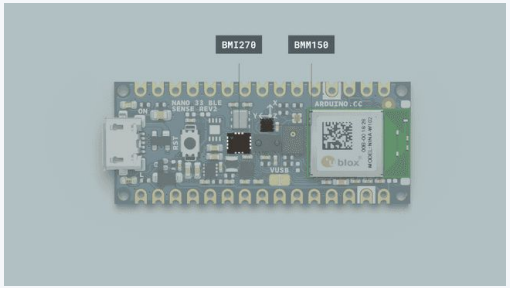
API

Hugging Face Server
(our classification model)

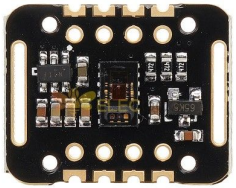
Block Diagram & Hardware Modules



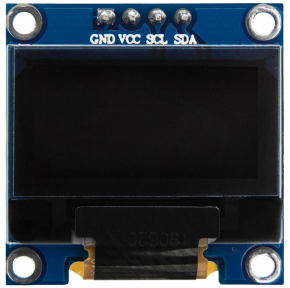
IMU



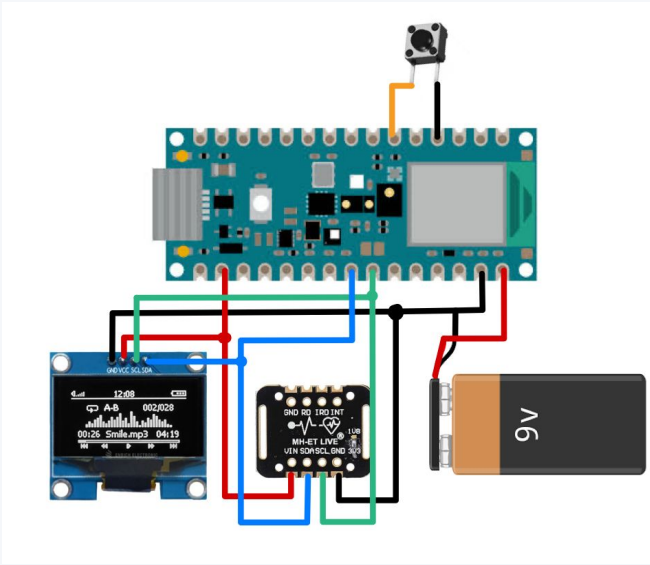
Max30102

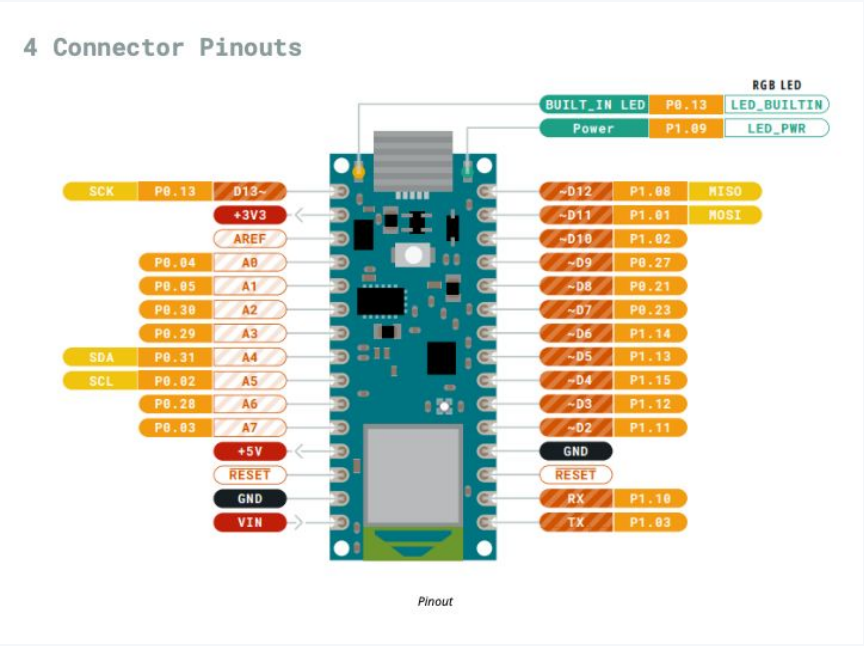


SSD1306



Circuit Diagram





Button: (+) ⟶ D3, (-) ⟶GND

Battery: (+) ⟶ Vin, (-) ⟶ GND

MAX30102: GND ⟶ GND, VCC ⟶ 3.3V, SCL ⟶ A5, SDA ⟶ A4

SSD1306: GND ⟶ GND, VCC ⟶ 3.3V, SCL ⟶ A5, SDA ⟶ A4

04

Implementation Details

Technical Skills

Frontend

NEXT.JS

Tailwind CSS

Backend & Authentication

Firebase

Website Deploy

Vercel

Machine Learning

PyTorch

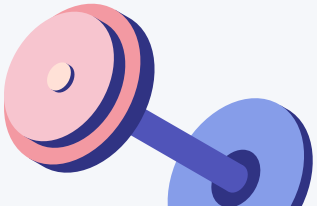
Model Deploy

Hugging Face

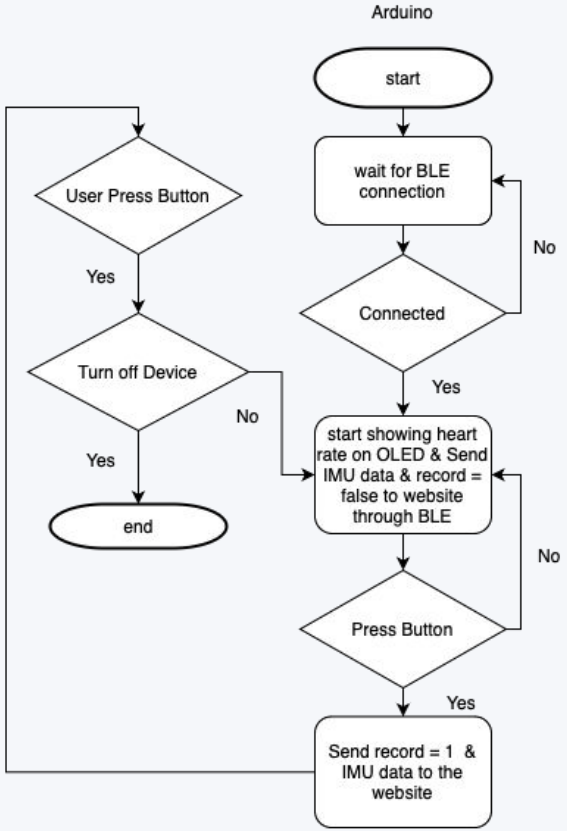
gradio

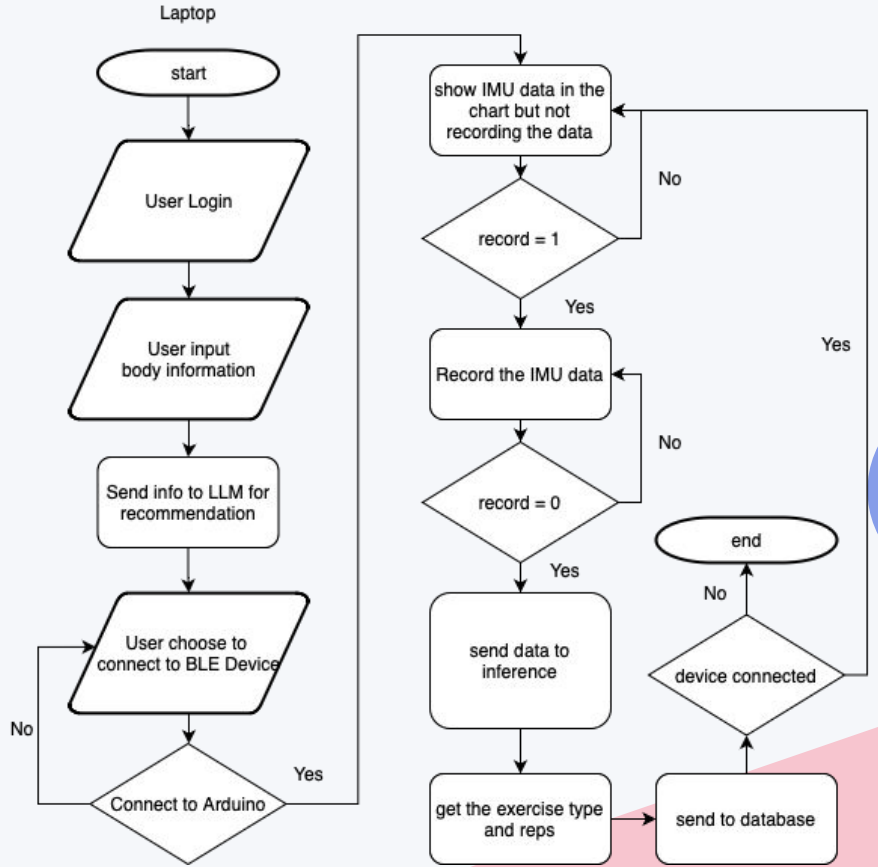
Arduino

ARDUINO

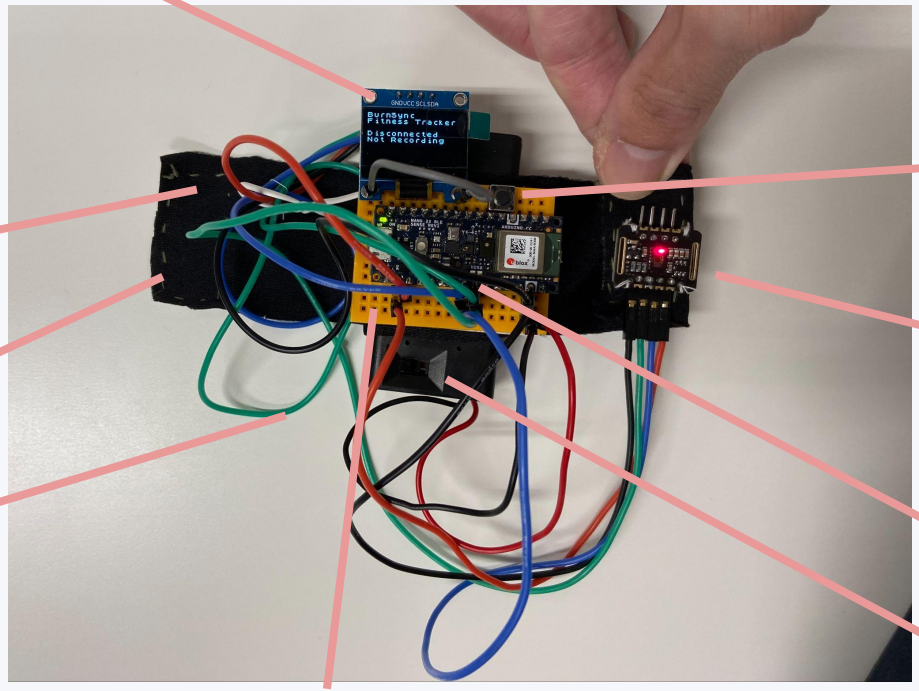


System Flow


Arduino
start
wait for BLE connection
Connected
No
Yes
User Press Button
Yes
Turn off Device
No
Yes
end
start showing heart rate on OLED & Send IMU data & record = false to website through BLE
Press Button
No
Yes
Send record = 1 & IMU data to the website


Laptop
start
User Login
User input body information
Send info to LLM for recommendation
User choose to connect to BLE Device
No
Connect to Arduino
Yes
show IMU data in the chart but not recording the data
record = 1
No
Yes
Record the IMU data
Yes
record = 0
No
Yes
send data to inference
get the exercise type and reps
send to database
end
No
device connected
Yes

Hardware Design



OLED (SSD1306)

stretchy fabric

Velcro（魔鬼氈）
(on the back,
sewn-on)

soft wires

Button

MAX30102
(sewn-on)

Arduino Nano

9V Battery

Bread Board

OLED Display

- Line 1: BurnSync
- Line 2: Fitness Tracker
- Line 4: Disconnected / Connected
- Line 5: Recording / Not Recording
- Line 7: Heart Rate
- Line 8: Avg BPM: [Number] / ???

Data Collection

- Steps:
  - Wearing Arduino Nano on the wrist
  - Connect Arduino and computer by BLE
  - Python code to collect the IMU data of Arduino and save as CSV file
  - 3 seconds(30 points) as a piece of data
  - Totally 400 piece of data for each class (300 from right hand and 100 from left hand)

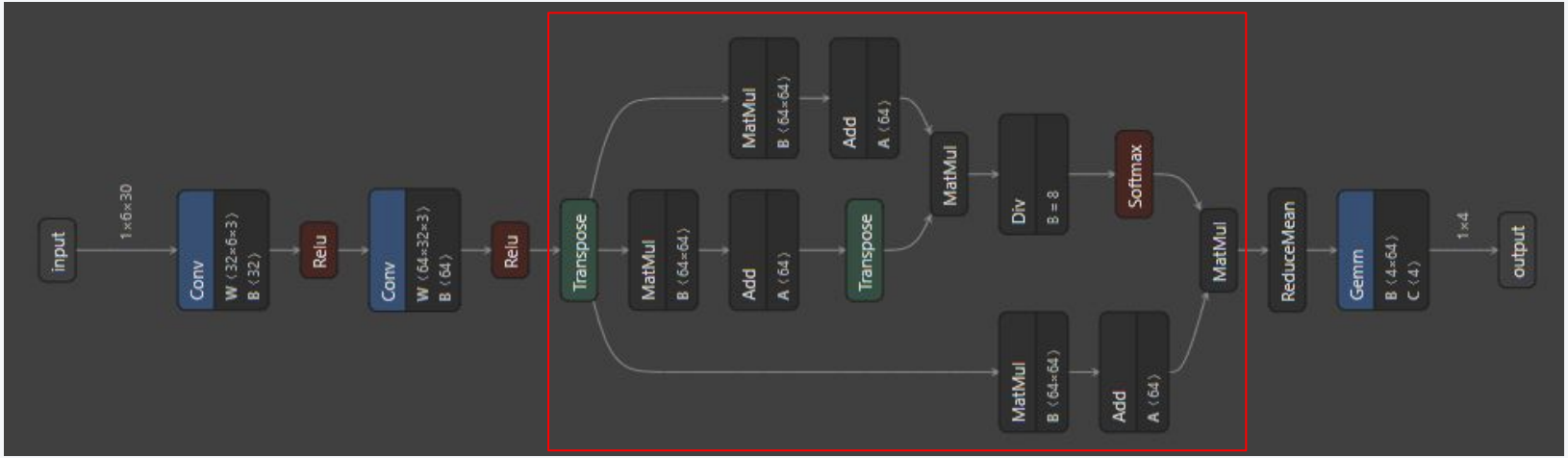
- Take only 6 channels of IMU → accelerometer 3 channels, gyroscope 3 channels
- Sample Rate: 10 Hz

Dataset

	Training 70%	Validation 15%	Testing 15%
Push-up	280 (reps)	60 (reps)	60 (reps)
Sit-ups	280 (reps)	60 (reps)	60 (reps)
Squats	280 (reps)	60 (reps)	60 (reps)
Dumbbells	280 (reps)	60 (reps)	60 (reps)

Model Architecture

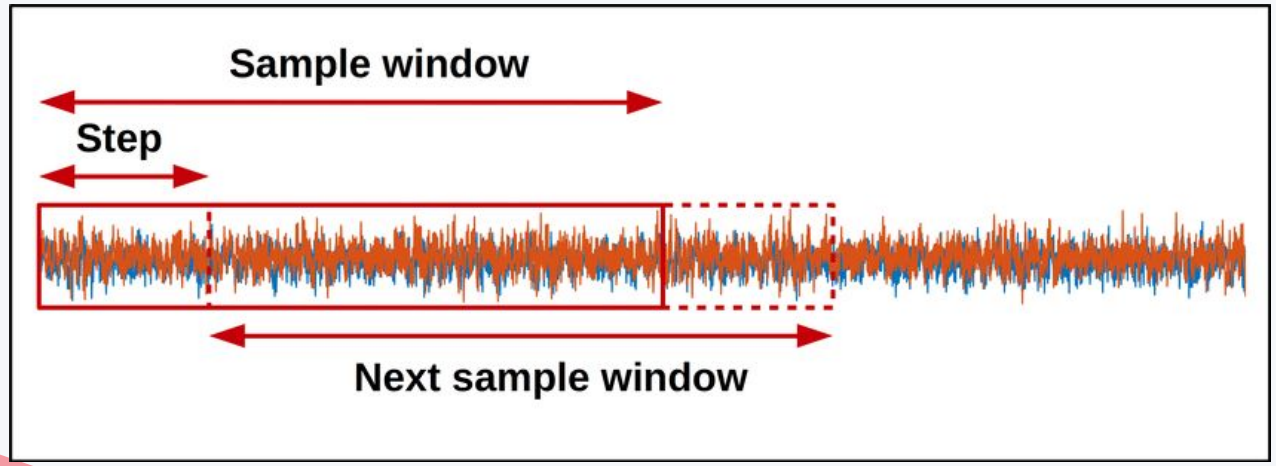
- Task: Classification – 4 classes
- Architecture: Attention with convolution
- Accuracy on testset: **98.75%**



Attention module

Sliding Window – Repetition Counting

- 1-Dimensional Sliding Window on six channels
- Window Size: 30
- Overlap: 15
- Step: Window - Overlap = 15



Inference Details

1. Receive a list of data with 6 channels
2. Apply **sliding window** on the time sequence data
3. For each window with **30 data points**, classify it into **4 classes**
4. If probability of 4 classes in model output are all **< threshold (0.7)**, classify it to **null**
5. If any class gets a probability **higher than threshold**, the **repetition** of that class **+ 1**
6. After the sliding window, get the class of the maximum repetitions, **clear other classes to zero**
   (Which means we **assume user do the same class each time**)

- Example:
  - { pushups: 8, squats: 1, situps: 3, dumbbells: 2 } →
    { pushups: 8, squats: 0, situps: 0, dumbbells: 0 }

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Conclusion

Efforts

Arduino

- Button & Pull-up resistance
- BLE Communication
- MAX30102 Module
- SSD1306 OLED Module
- Hardware Design

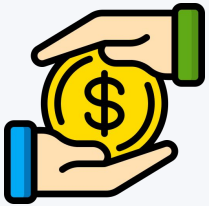
Website

- Frontend UI Design
- RWD Design
- Authentication
- Database Connection

Machine Learning

- Gemini LLM API
- Custom Model Training
- Dataset Collection
- Hugging Face Space Deploy
- Gradio API Connection

Contributions

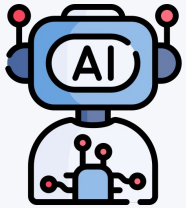


—Cheap & Affordable

Below 500 NTD (excluding Arduino Nano)

—Insight on Fitness IMU Data

Left or right hand does not affect result



—LLM Integration & Diverse Development Potential

Hosting our own website and handmade device provide high flexibility

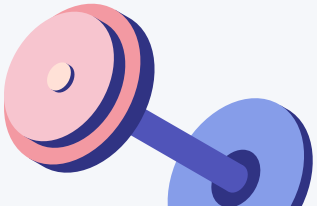
Major Problems

Repetition Count Accuracy

- Miscounting repetitions
- Possible solutions
  - Normalization
  - Feature extraction
  - Fine tuning or Calibration
  - Adjustable threshold & overlap

Heart Rate Accuracy

- Poor heart rate detection
- Possible solutions:
  - Use other sensors
  - Calibration



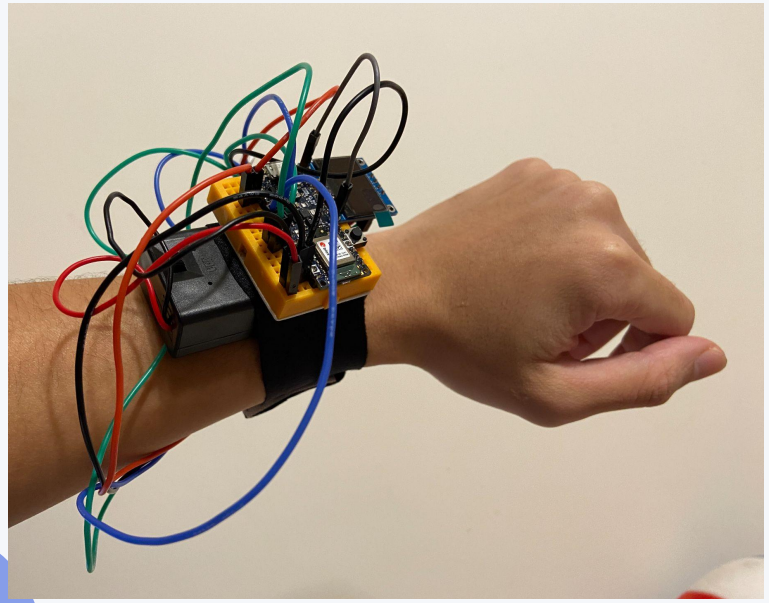
Future Work

Higher Accuracy

Better Encapsulation

Massive User Study

More Types of Exercise



Conclusion

BurnSync

1. Personal fitness assistant
2. Convenience
3. Ubiquitous
4. Cheap
5. High potential for future development

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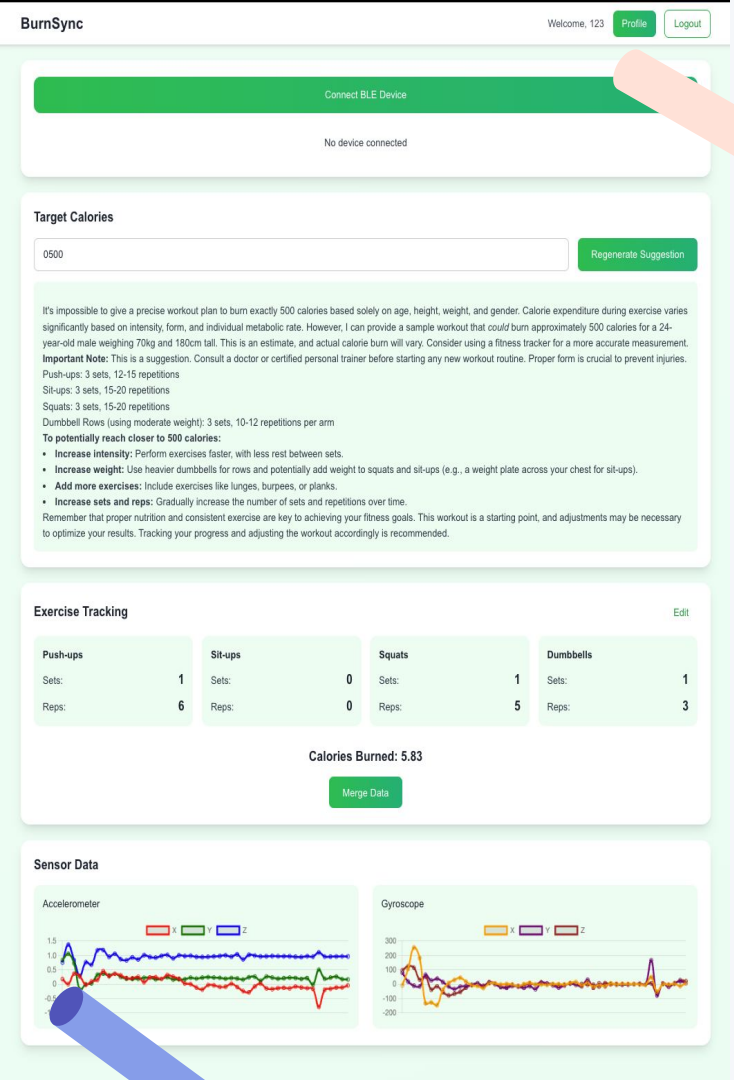
Live Demo



BurnSync Demo

- Website
- Login
- Edit profile
- LLM Suggestion
- Live IMU data
- 4 classes tracking
- Edit tracking
- Merge data

If you use iPhone, you need to download **Bluefy** and use it as browser since Apple do not make their bluetooth available for browser

THANKS!

DO YOU HAVE ANY QUESTIONS?