Progress report

Fall detection device

with smartphone notification system

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Abstract

Aging is a global demographic shift with far-reaching consequences for healthcare systems.

Falls pose a significant health risk for older adults, leading to injuries, reduced quality of life, and increased healthcare costs.

Remote and wearable technology offers a promising solution to address this growing challenge by enabling early detection and prevention of falls.

As the elderly population continues to expand, the development and implementation of innovative fall prevention strategies are essential to ensure the well-being and independence of older adults.

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Introduction

Our project aims to reduce mortality rates among the elderly caused by fall and implement techniques to detect fall detection as a wearable device .

We recognize the importance of the elder's activities that can lead to mortality rates and intend to study and develop innovative methods to reduce mortality rates caused by falls.

Project Overview

The Fall Detection System project aims to develop a reliable, real-time monitoring solution that can automatically detect falls and provide immediate alerts to prevent severe injuries or fatalities. This project focuses on protecting vulnerable individuals.

Project Goals

- Accurate Detection
- Real-Time Alerts
- User-Friendly Design
- Reduce mortality and injury rates from falls

Project Objectives

- Prevent injuries
- Increase safety
- Reduce anxiety
- Support health technology

Dataset

A dataset in Fall Detection refers to a collection of data used to train, test, and evaluate fall detection models. Typically, in the process of developing a fall detection model, a dataset is used in the following steps:

Activities of Daily Living

[1]

Task ID	Activity	Trials
D01	Stand for 30 s	1
D02	Stand, slowly bendthe back with or without bending at knees, tie shoe lace, and get up	5
D03	Pick up an object from the floor	5
D04	Gently jump (try to reach an object)	5
D05	Stand, sit to the ground, wait a moment, and get up with normal speed	5
D06	Walk normally with turn (4 m)	5
D07	Walk quickly with turn (4 m)	5
D08	Jog normally with turn (4 m)	5
D09	Jog quickly with turn (4 m)	5
D10	Stumble while walking	5
D11	Sit on a chair for 30 s	1
D12	Sit on the sofa (back is inclined to the support) for 30 s	1
D13	Sit down to a chair normally, and get up from a chair normally	5
D14	Sit down to a chair quickly, and get up from a chair quickly	5
D15	Sit a moment, trying to get up, and collapse into a chair	5
D16	Stand, sit on the sofa (back is inclined to the support), and get up normally	5
D17	Lie on the bed for 30 s	1
D18	Sit a moment, lie down to the bed normally, and get up normally	5
D19	Sit a moment, lie down to the bed quickly, and get up quickly	5
D20	Walk upstairs and downstairs normally (five steps)	5
D21	Walk upstairs and downstairs quickly (five steps)	5

Fall

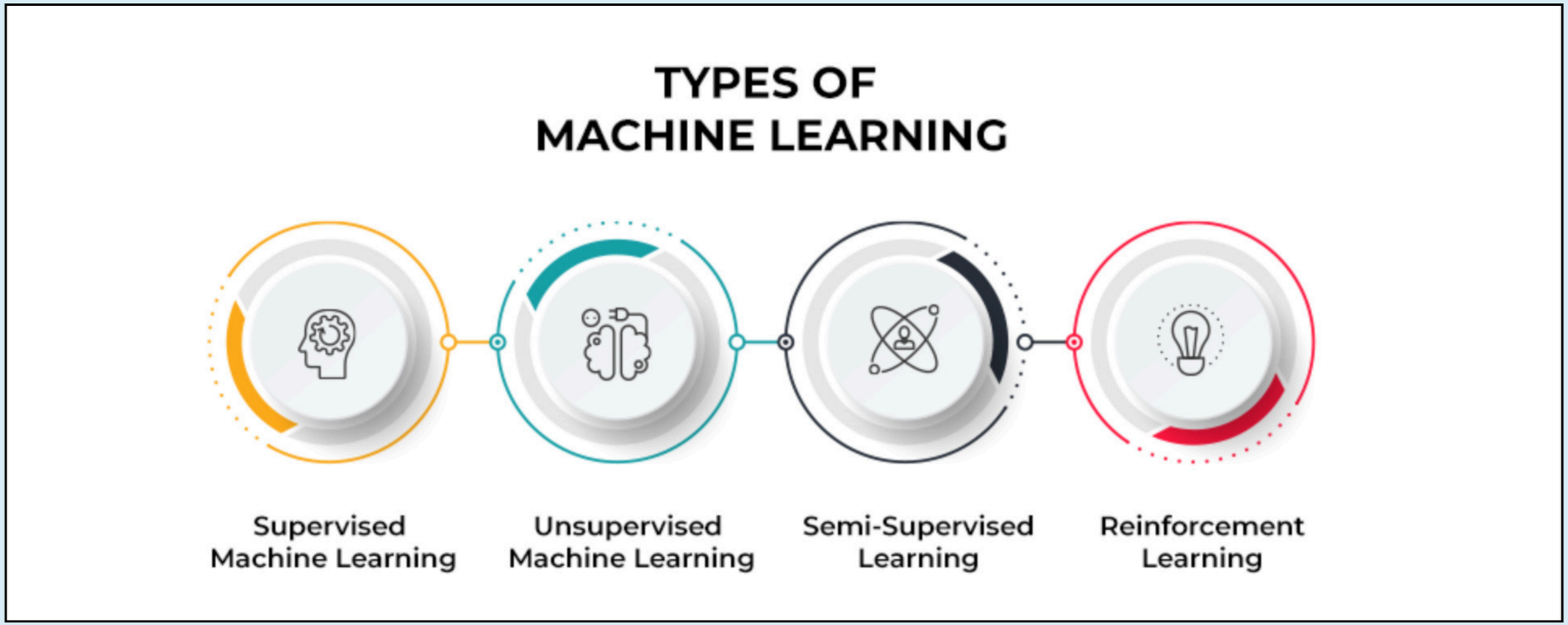
[1]

F01	Forward fall when trying to sit down	5
F02	Backward fall when trying to sit down	5
F03	Lateral fall when trying to sit down	5
F04	Forward fall when trying to get up	5
F05	Lateral fall when trying to get up	5
F06	Forward fall while sitting, caused by fainting	5
F07	Lateral fall while sitting, caused by fainting	5
F08	Backward fall while sitting, caused by fainting	5
F09	Vertical (forward) fall while walking caused by fainting	5
F10	Fall while walking, use of hands to dampen fall, caused by fainting	5
F11	Forward fall while walking caused by a trip	5
F12	Forward fall while jogging caused by a trip	5
F13	Forward fall while walking caused by a slip	5
F14	Lateral fall while walking caused by a slip	5
F15	Backward fall while walking caused by a slip	5

Machine learning (ML)

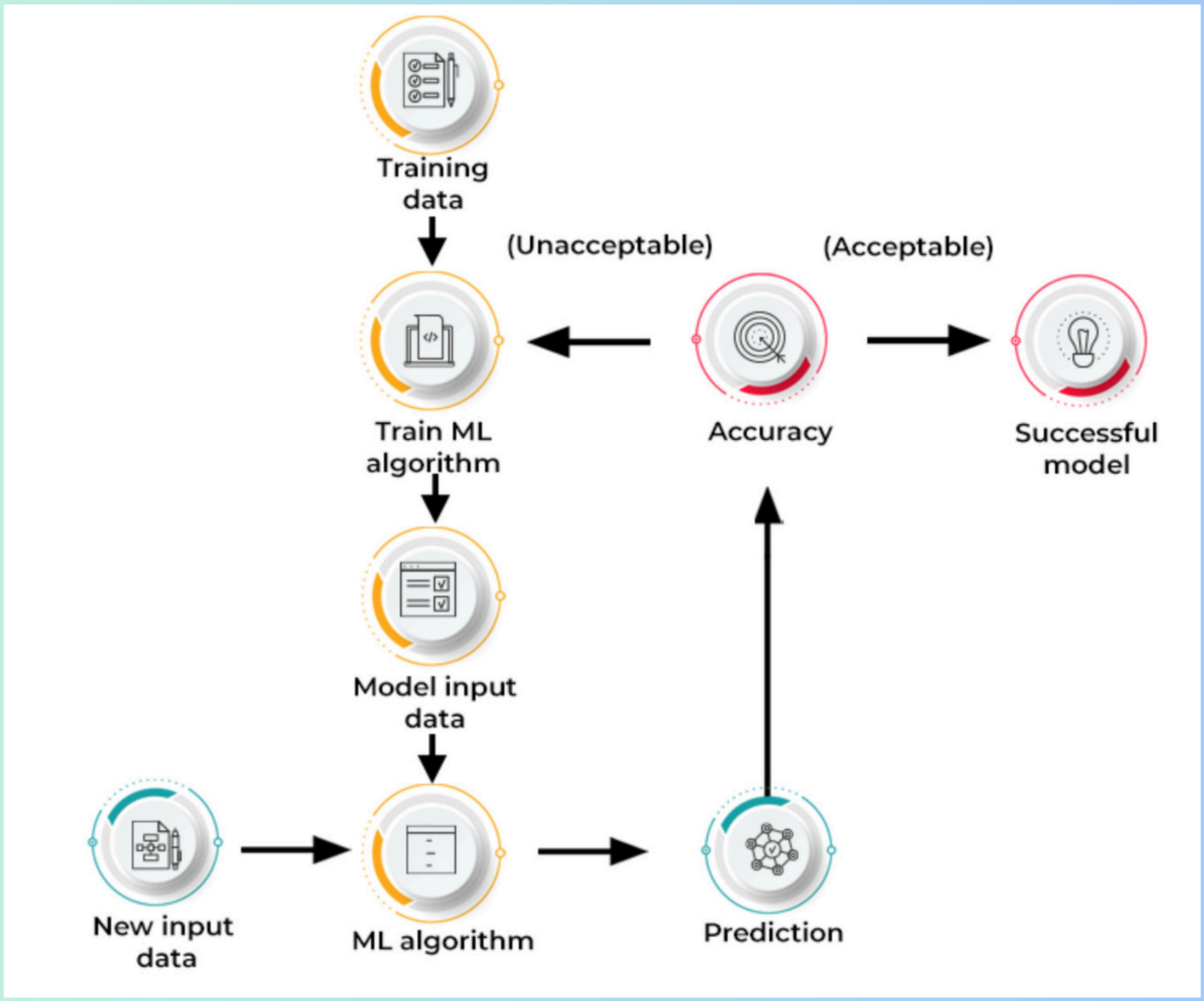
[2]

Machine learning teaches machines to learn from data and improve without being explicitly programmed.



How does machine learning work?

[2]



System overview

[2]

Data collection

- Human motion capture

The collected data will be analyzed to identify movement patterns indicative of falls.

Data Preprocessing

- Data cleaning

The dataset was cleaned to remove outliers and inconsistencies.

Feature Extraction

- Finding key features in data indicating a fall

A sudden increase in vertical acceleration, combined with a high peak in angular velocity, can be indicative of a fall.

- Developing a model to predict falls

Machine Learning Algorithm

Performance Evaluation

- Evaluate the system's performance using a dataset and assess its ability to detect falls.

By conducting extensive testing on a diverse dataset, we can evaluate the system's ability to accurately detect falls in various scenarios and identify areas for improvement, such as false positives and false negatives.

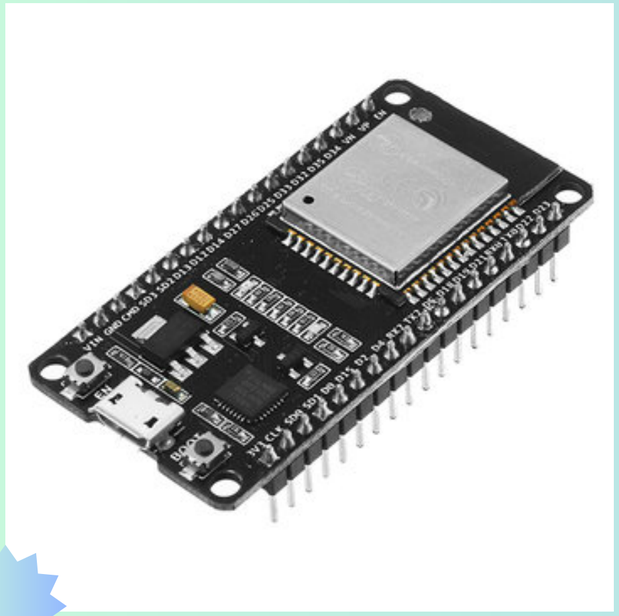
Machine Learning Algorithm

[2]

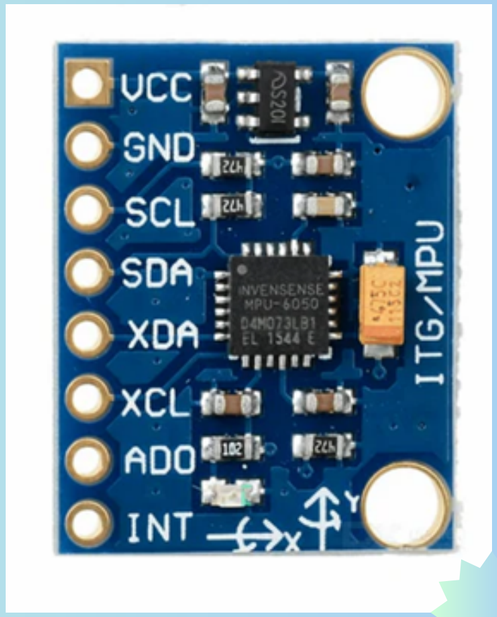
ML Algo	Sensor	Sensor Placement	Accuracy	Sensitivity	Specificity
SVM	IMU	Waist	98%	100%	100%
		Wrist	91.13%	99%	NA
	SmartPhone (IMU)	Waist	97.80%	99.50%	95.20%
		Thigh	91.70%	95.80%	88.00%
kNN	IMU	Wrist	99%	99%	NA
		Waist	99.78%	100%	99.91%
		5th lumbar vertebra and sacrum	99.40%	NA	NA
ANN	IMU	Waist	95.25%	96.50%	94.00%
	SmartPhone (IMU)	Wrist	92.96%	99.45%	100%
	IMU	L5 vertebra	96.3%	NA	NA
RF	IMU	Hip	73.70%	84%	NA
		Lower legs, posterior pelvis	77.30%	66.10%	84.70%
	SmartPhone (IMU)	Hand	NA	99%	98%

Hardware

1. ESP32



2. IMU Sensor MPU6050

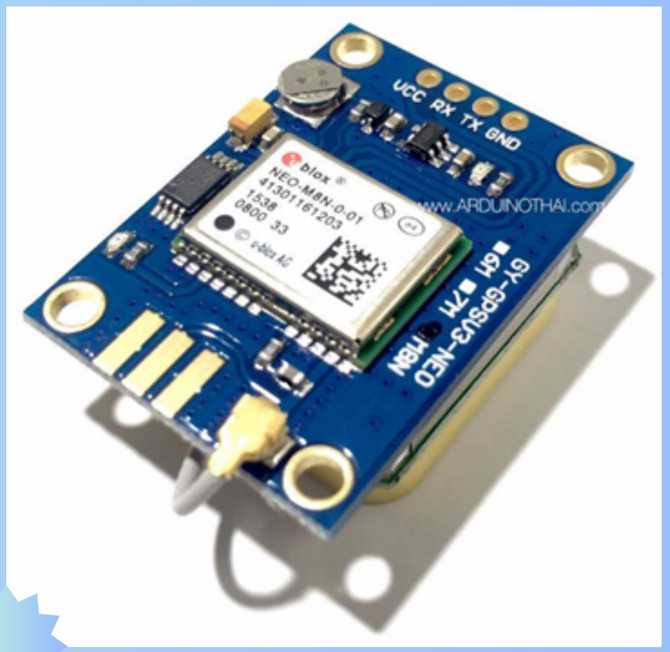


3. Passive Buzzer

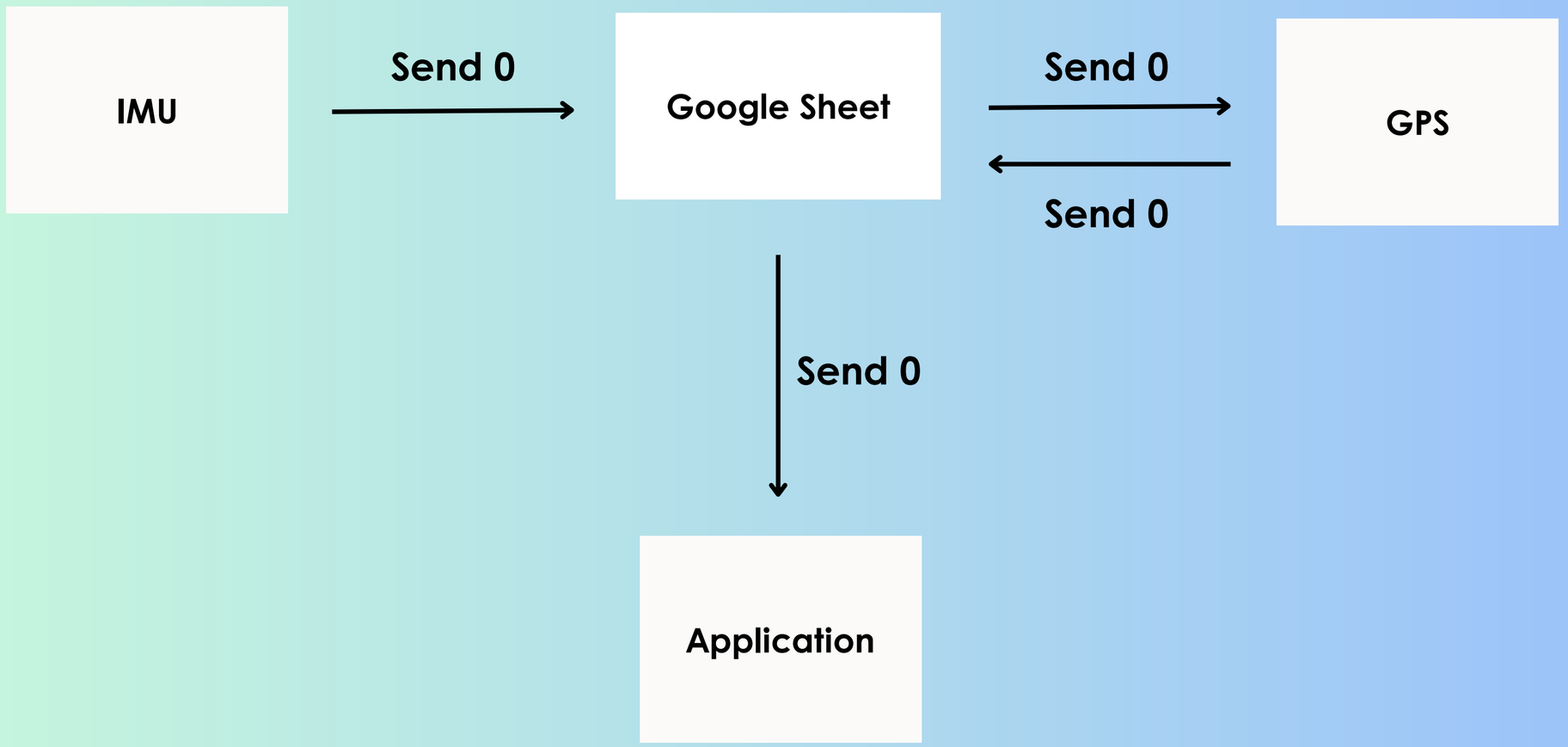
4. LED

5. Push Button Switch

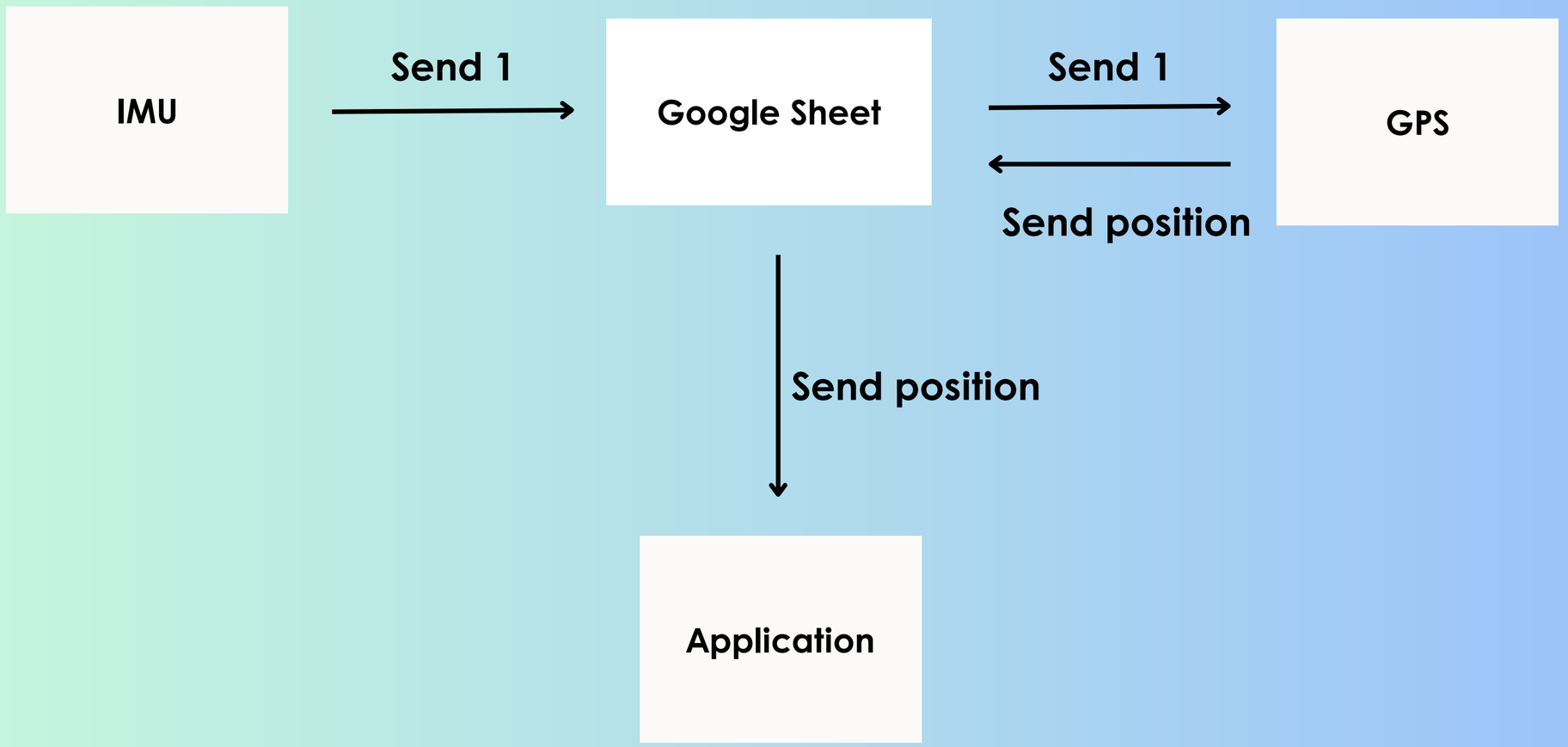
6.GPS Module NEO-M8N



Software

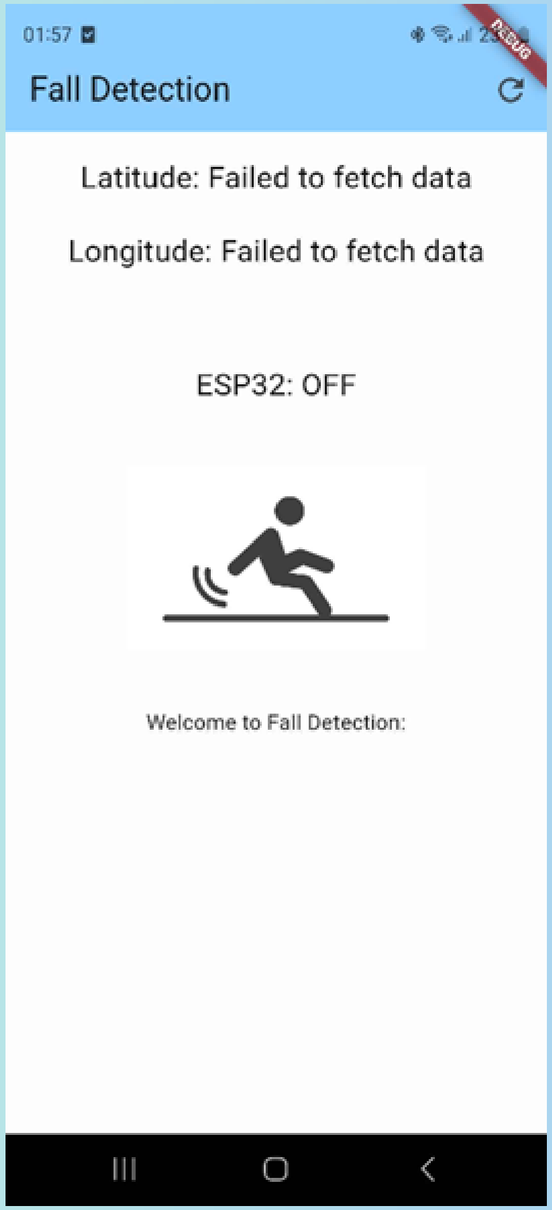


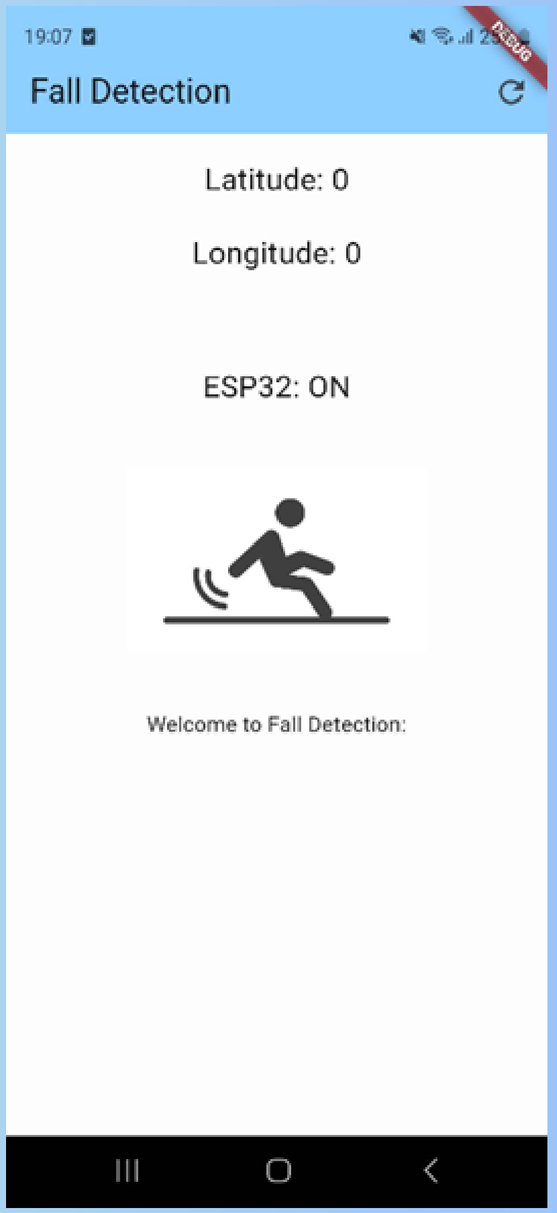
Software


IMU
Send 1
Google Sheet
Send 1
GPS
Send position
Send position
Application

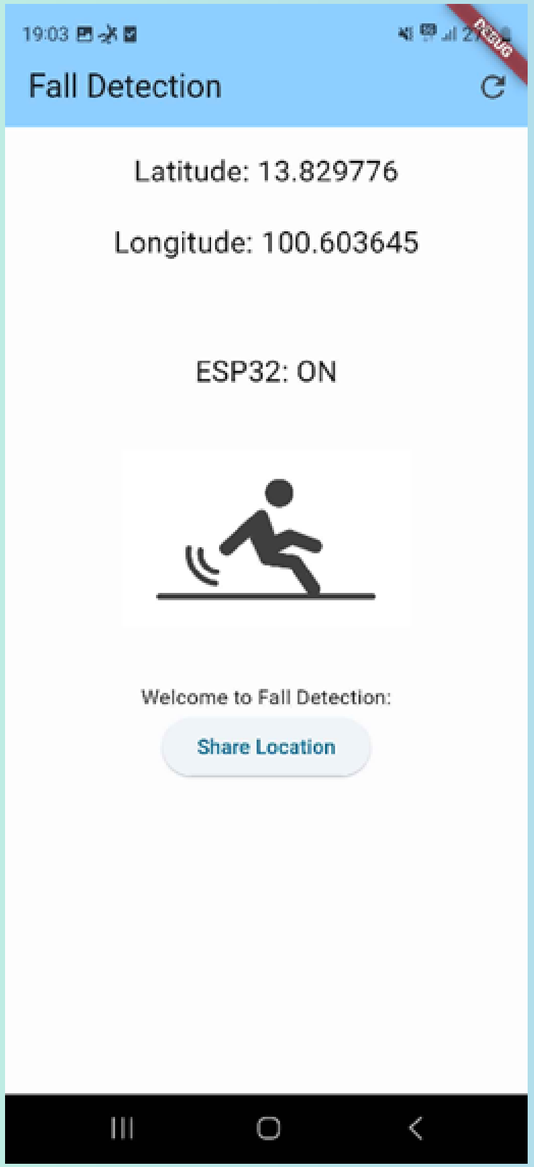
Application

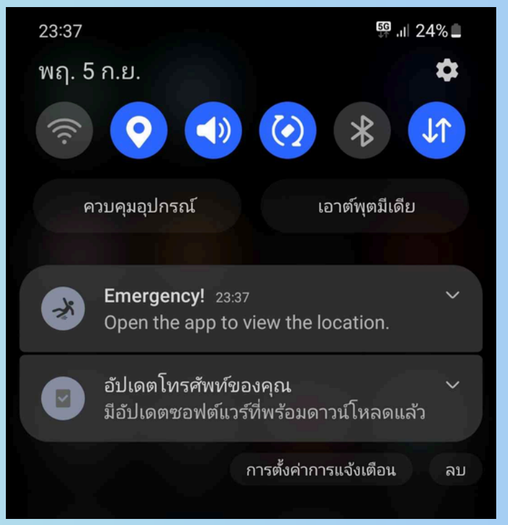
1. Open & Close Device

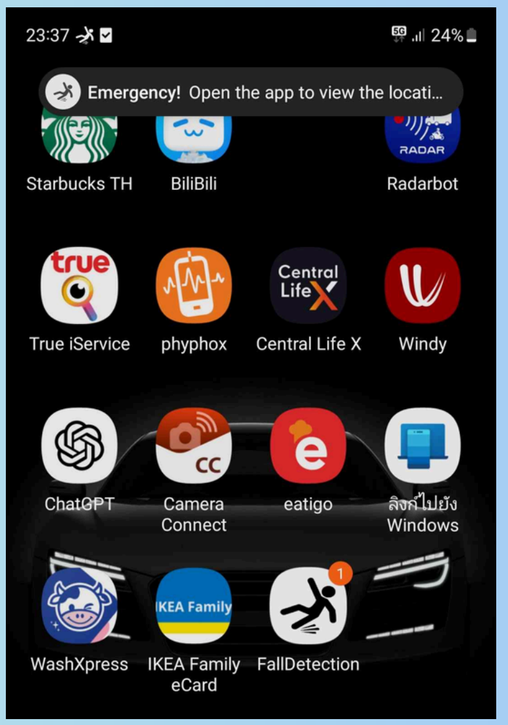


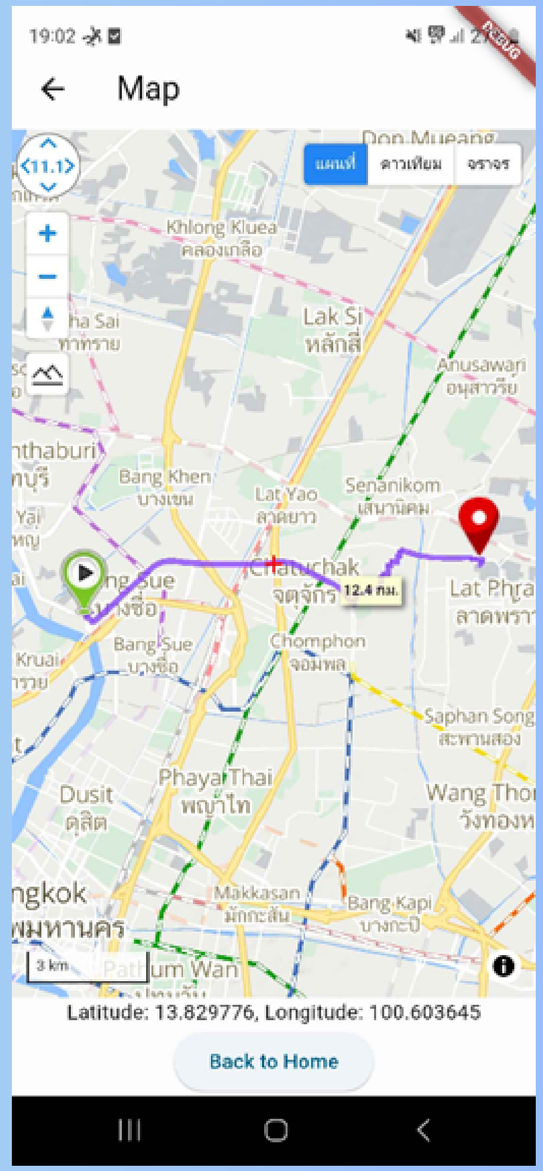


2. When a fall occurs

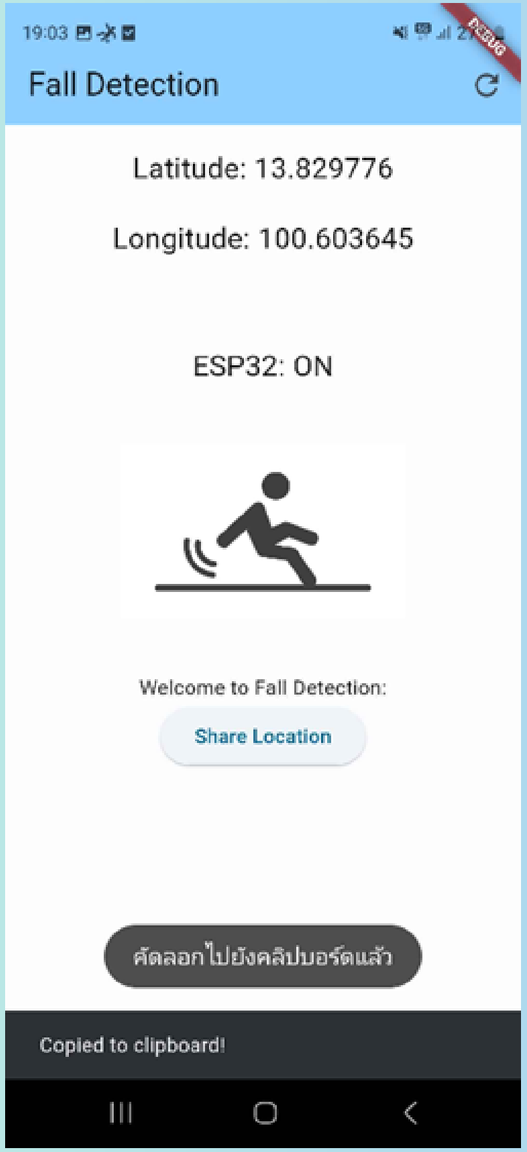


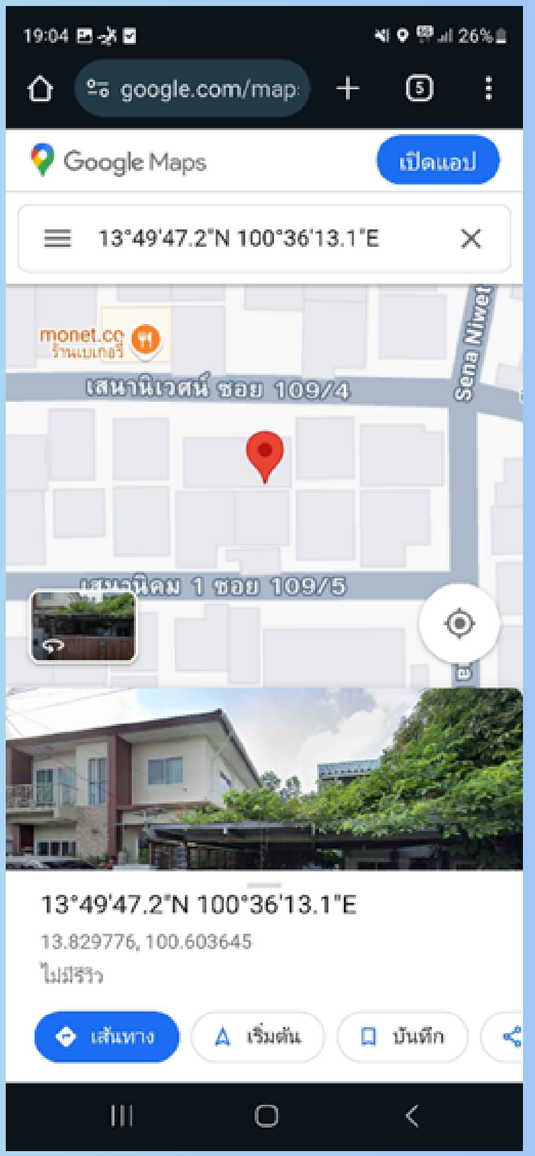




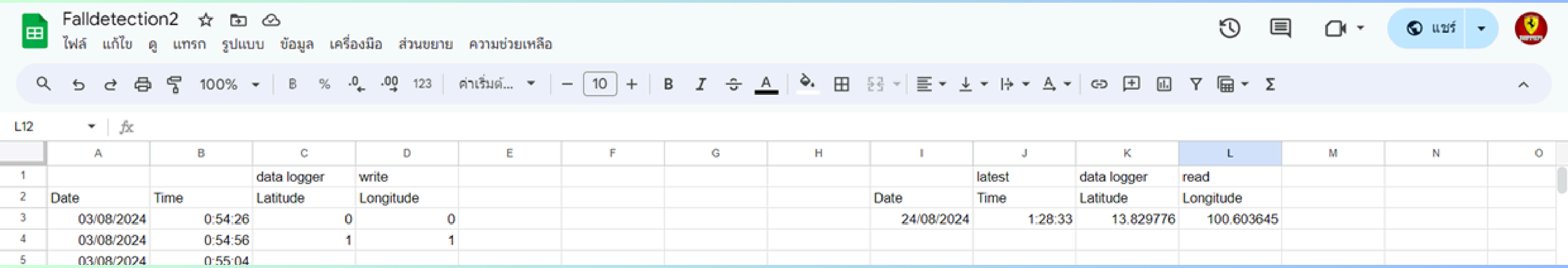


3. Share Location





4. To examine the record of previous falls



Falldetection2

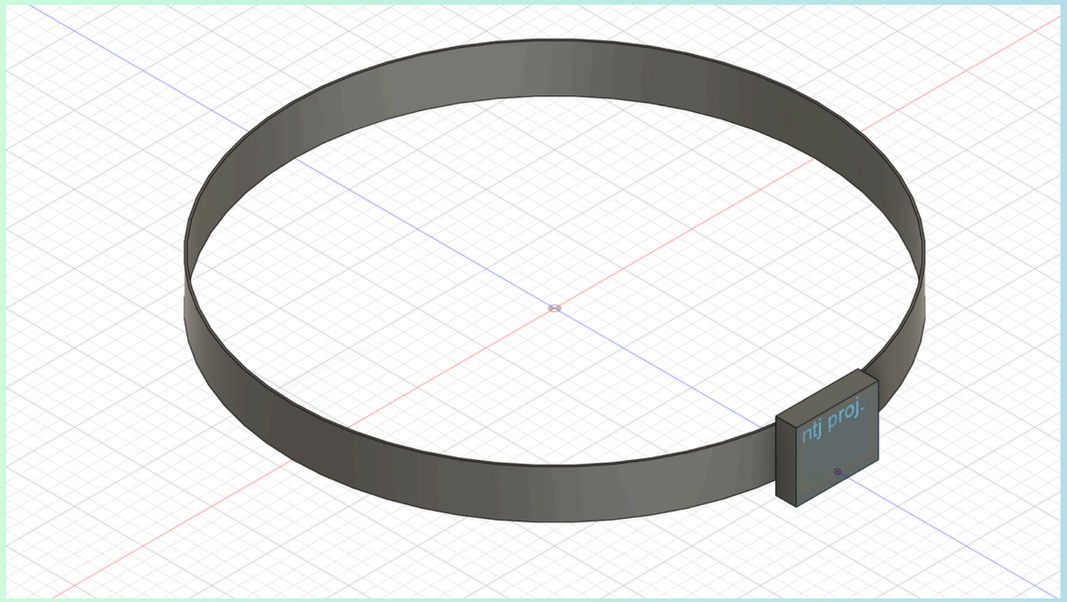
ไฟล์ แก้ไข ดู แทรก รูปแบบ ข้อมูล เครื่องมือ ส่วนขยาย ความช่วยเหลือ

แชร์

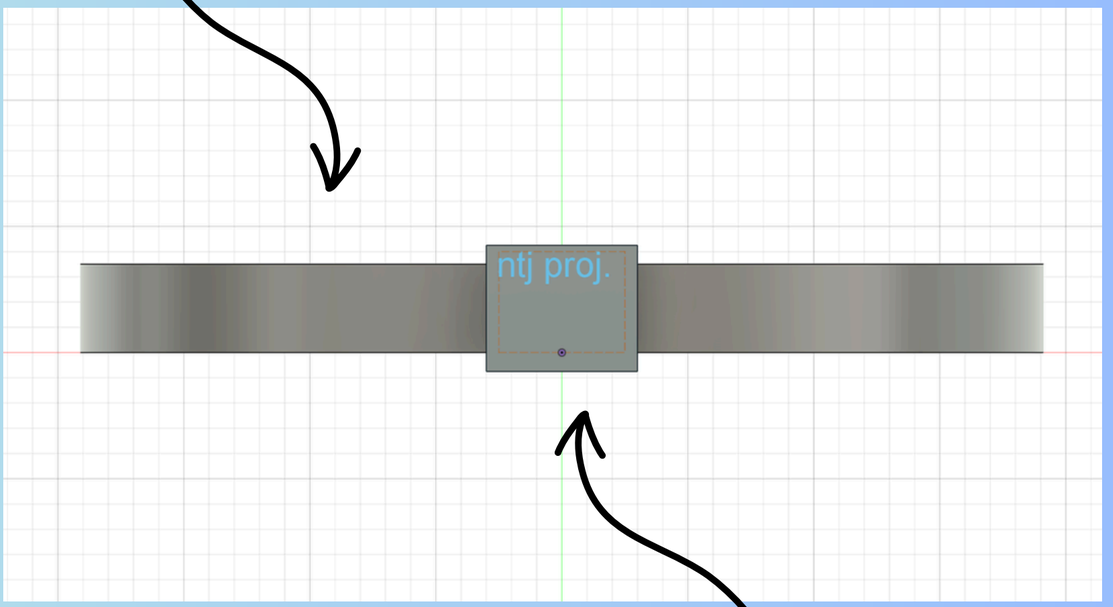
L12

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1			data logger	write						latest	data logger	read			
2	Date	Time	Latitude	Longitude					Date	Time	Latitude	Longitude			
3	03/08/2024	0:54:26	0	0					24/08/2024	1:28:33	13.829776	100.603645			
4	03/08/2024	0:54:56	1	1											
5	03/08/2024	0:55:04													

Design



Belt



Detector

Session planing

ขั้นตอน	รายละเอียด	ปี2567						ปี2568			
		ก.ค.	ส.ค.	ก.ย.	ต.ค.	พ.ย.	ธ.ค.	ม.ค.	ก.พ.	มี.ค.	เม.ย.
1	ศึกษาDataset										
2	ศึกษาML										
3	ศึกษาIEC 63203 และ IEC 60601										
4	ออกแบบอุปกรณ์ Fall Detection										
5	เขียนร่างโครงงาน นำเสนอความคืบหน้าโครงงาน										
6	สร้างอุปกรณ์ Fall Detection										
7	ทดสอบ วิเคราะห์และปรับปรุงอุปกรณ์ Fall Detection										
8	เขียนรายงานและนำเสนอโครงงาน										

Next tasks

- Select an algorithm for Machine Learning
- Design PCB Board
- Training data

Obstacle

- Some parts cannot be carried out according to the planned operation.
- GPS installation positioning sometimes cannot detect the location.

Overall operation

- Sensors and sensors position
- Dataset used for training data
- Equipment to be used to create fall detection

Reference

[1] Yu, X., Jang, J., & Xiong, S. (2021). A Large-Scale open motion dataset (KFALL) and benchmark algorithms for detecting pre-impact fall of the elderly using wearable inertial sensors. Frontiers in Aging Neuroscience, 13. doi: 10.3389/fnagi.2021.692865

[2] Kanade, V. (2024, May 13). What is machine learning? Understanding types & applications. Spiceworks Inc. https://www.spiceworks.com/tech/artificial-intelligence/articles/what-is-ml/