Smart Mailbox Sorter: Automated Residential Mail Management System (SSM-ARMS)

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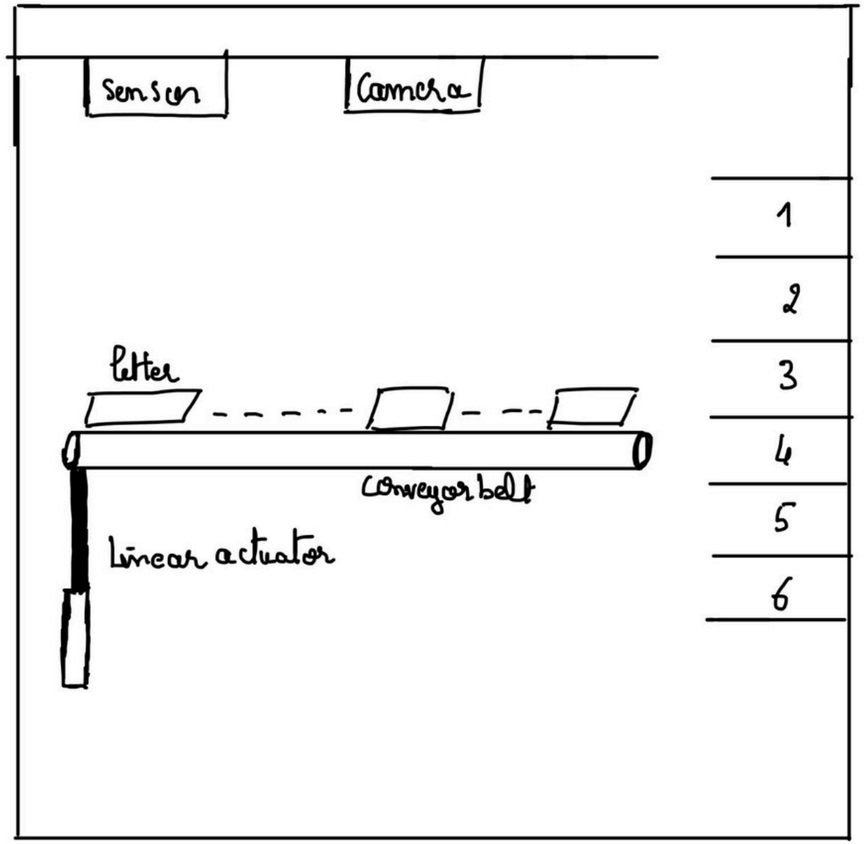
Project Description-elevator pitch

An automated mail sorting system designed to streamline letter distribution for apartment complexes.

- Uses a conveyor belt to transport letters.
- Controlled by Raspberry Pi for precise movement.
- Integrates camera and AI for accurate letter identification.
- Linear actuator positions the belt for correct compartment alignment.



Our goal for this semester

- Enhance AI accuracy for letter reading.
- Implement motor control for conveyor belt rotation.
- Integrate linear actuator for conveyor belt alignment.
- Develop web application and database for resident management.
- Finalize the prototype of the mailbox

Project Architecture

Requirements to be satisfied in this semester

Functional requirements

- **Mail Handling via Conveyor Belt :** The conveyor belts sort mails to the correct apartment
- **Mail Sorting Mechanism:** Recognize the address of the recipient to determine the corresponding box.
- **Delivery Process:** Once the appropriate level is reached, the internal conveyor belt will push the mail into the designated apartment's mailbox.
- **Mailbox Reset :** After delivery, the conveyor system resets its position to the default state for processing the next piece of mail
- **Address Readability:** AI model should be able to identify the apartment number from the address written on letterhand.

Non-Functional requirements

- **Scalability:** Adaptable to different sizes.
- **Energy Efficiency :** The system must optimize power usage, particularly for the conveyor belts, actuators.
- **Security :** The mailbox compartments should be secure, preventing unauthorized access.
- **Integration:** The system should integrate seamlessly with the Raspberry Pi also with other hardware components.

Update in Hardware Components

Item identification webcam:

Logitech C270

Automated Transport Motor

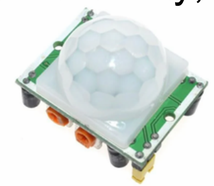
Moteur DC 775, tension 12V/24V, vitesse 6000 RPM à 12V et 12000 RPM à 24V, couple élevé, faible bruit, support inclus pour montage facile.

12V 10A Power Adapter for Motor Power Supply

Powers 12V DC motors and linear actuator, stable 12V output at 10A, ensures reliable motor operation, compatible with L298N driver.

Proximity Sensor:

HC-SR501 based on infrared technology, high sensitivity, high reliability, ultra-low-voltage operating mode

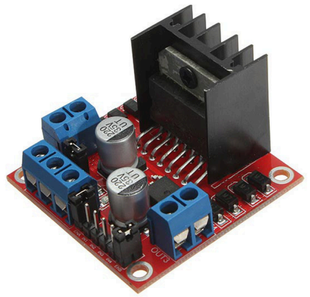


The linear acurator:

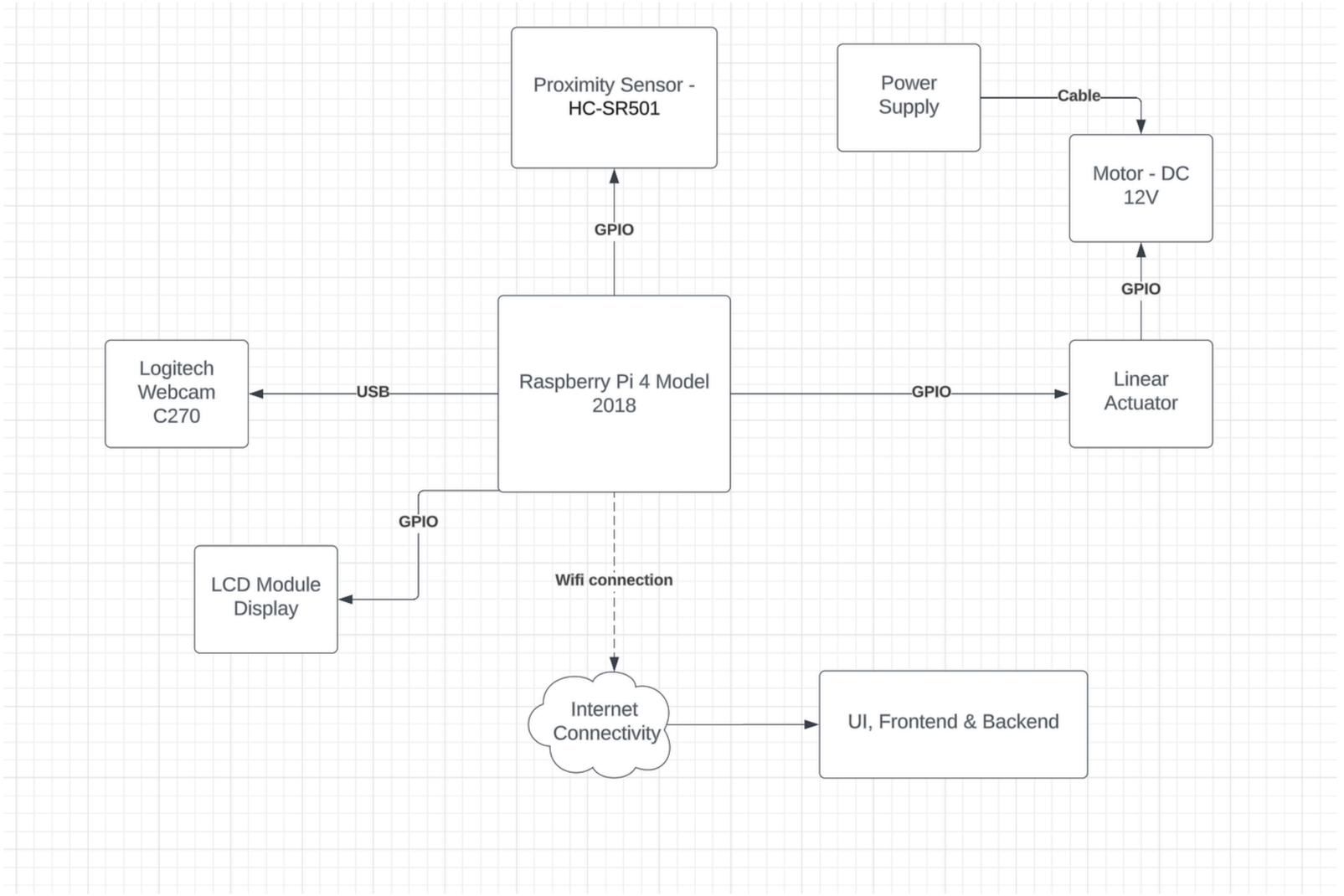
12V DC linear actuator, high speed of 10mm/s, 900N load capacity, multiple sizes available, includes mounting brackets for easy installation.

L298N Motor Driver Module

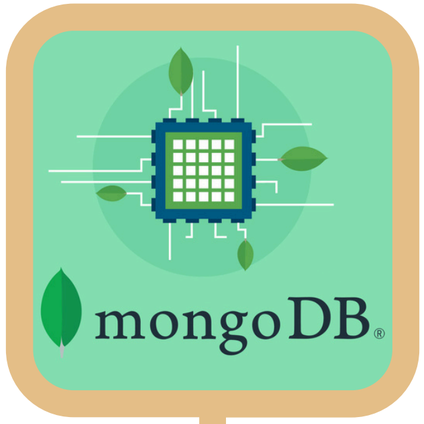
DC 775 motor, 12V/24V, 6000/12000 RPM, high torque, low noise, includes mounting bracket.



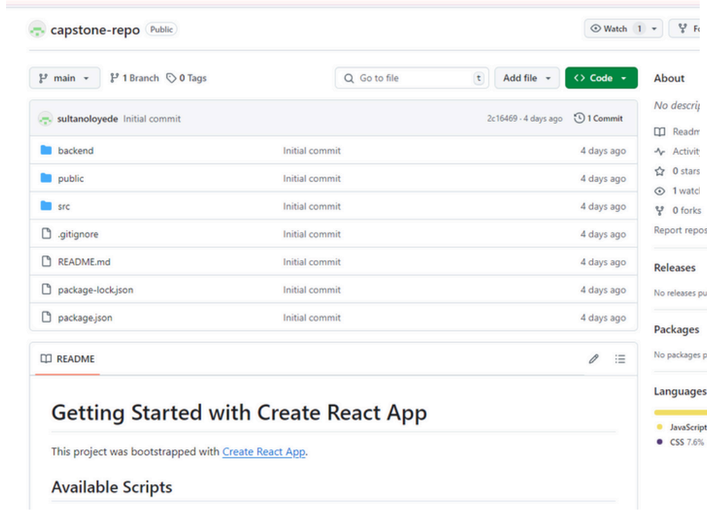
Hardware Architecture

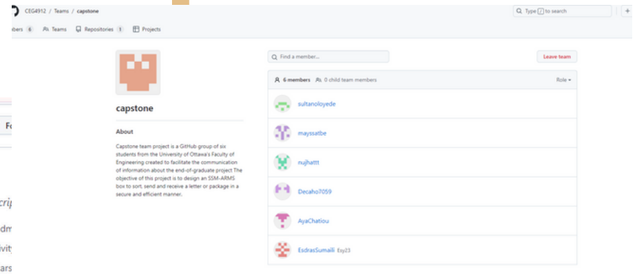


Software Architecture



- Motor Control Library (RPi.GPIO)
- Message Display Library (RPLCD)
- Image recognition OpenCV, Tensorflow
- ML training with MNIST dataset
- Web application made with Python using Flutter
- MongoDB Configuration





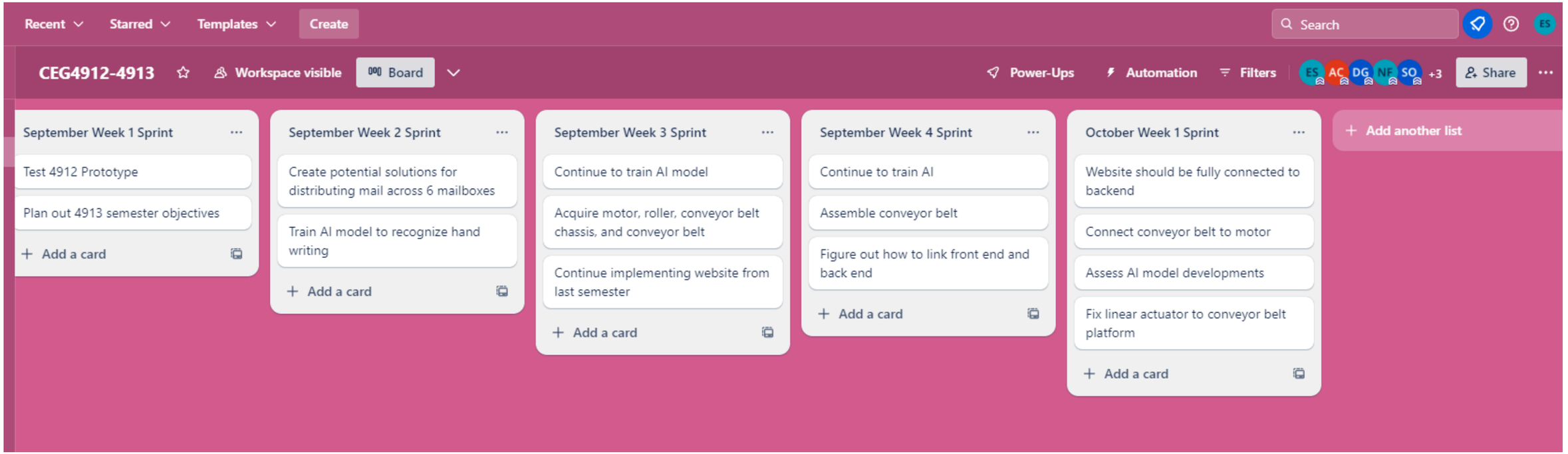
WBS


SSM-ARMS WBS
Project Planning
Done
Purchase Materials
Done
Gather Hardware and Software Requirements
Done
Analyze Requirements
Done
Document Requirements
Done
Requirements Review
Done
Hardware
In progress
System Architecture Design
Done
Component Selection
Done
Sensor Integration with System
Done
Motor Plate Design for Sorting Mail
Done
Power Supply Design and Implementation
Done
Wiring Connection and Setup
In progress
Mechanical Structure Design and Implementation
In progress
Prototype Assembly
In progress
Software
In progress
Backend Development
In progress
Database Implementation
In progress
Server-side Logic
In progress
Front-End Development
In progress
User Interface Implementation
In progress
AI Calibration of Letter Address Reading
In progress
Integration of hardware with software components
In progress
Documentation Formatting
In progress
Testing
To do
Unit Testing
In progress
Integration Testing
In progress
System Testing
In progress
Performance Testing
In progress
Testing Documentation
In progress
Screen Implementation to address letter detection
Done
AI Data collection of different handwriting styles
ML training system to read address
Deployment/Maintenance
In progress
Configuration of Equipment
In progress
Implementing Mail Box
In progress
Bug Fixes
In progress
Report writing
In progress
Documentation Maintenance
In progress

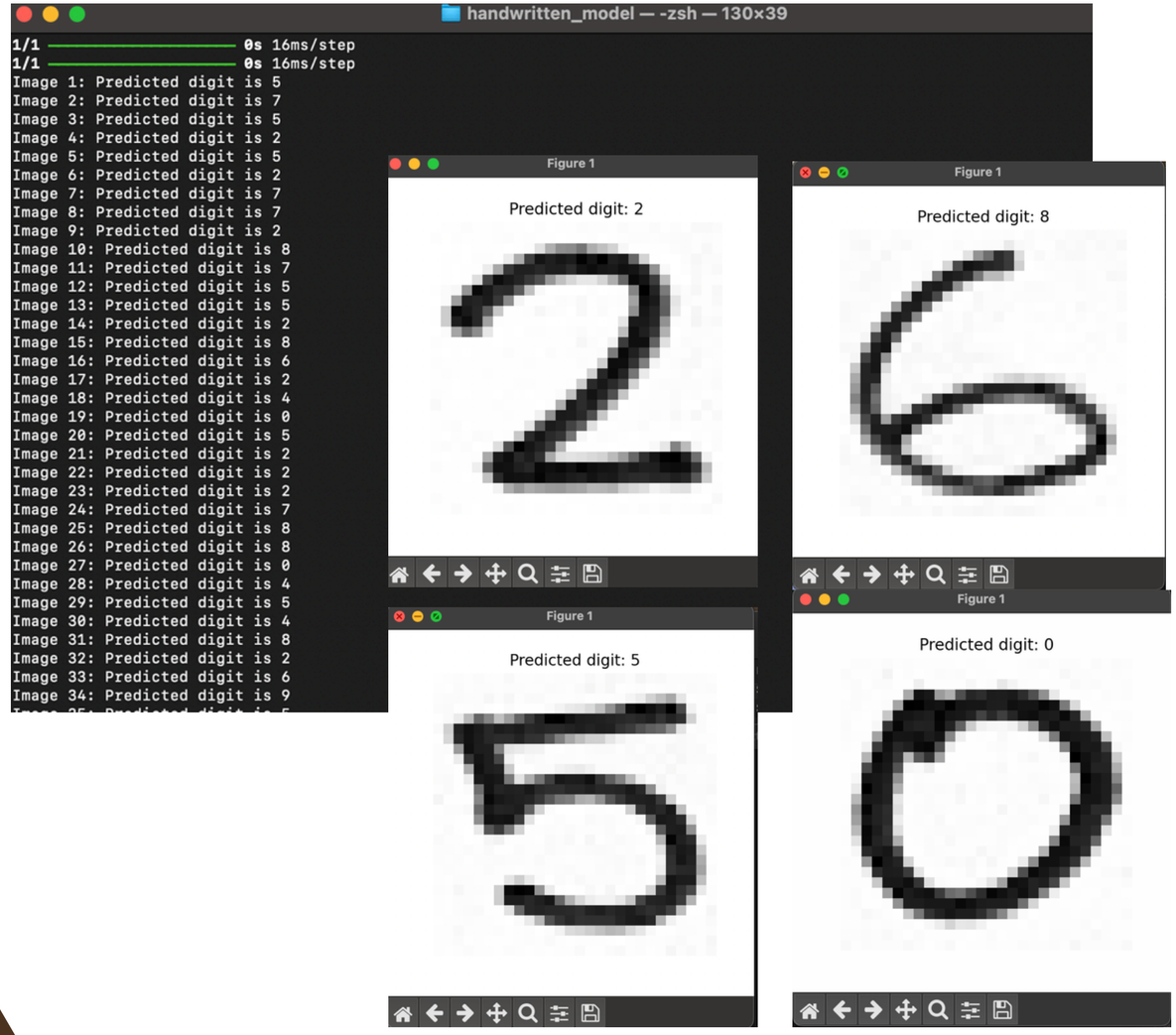
Gantt Chart


1 Project Documentation
2 Project Proposal
3 WBS
4 Gantt Chart
5 Trello Board
6 Acquire Materials
7 Initialize GitHub
8 IR Sensor Configuration
9 Program to detect objects
10 Integrate with camera
11 Display object detected on LED Screen
12 First Half of Mailbox
13 AI identifies Letter
14 AI identifies Address
15 Create test cases for AI
16 Configure motor control
17 Build Mailbox Structure
18 Second Half of Mailbox
19 Image-to-Text Interpretation
20 Strip text for Apt #
21 Displays Apt # on LED
22 Sync motor to Apt box
23 Construct motorized platform for letter
24 Initialize database for recipient details
25 Testing
26 User Application
27 Notification system for receipients
28 Synchronize user procedure with database

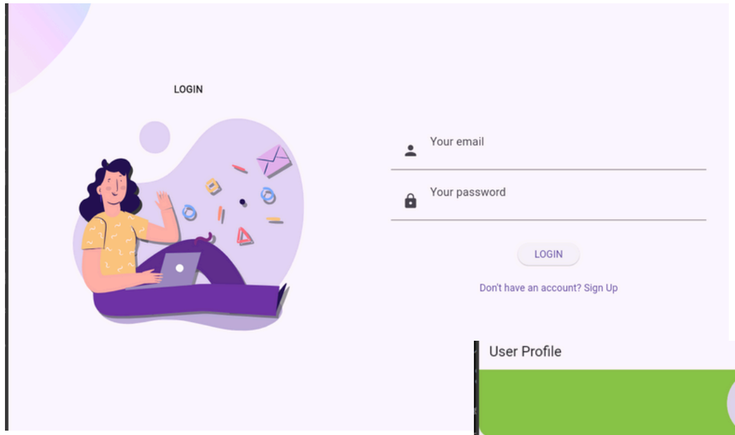
Management using Trello



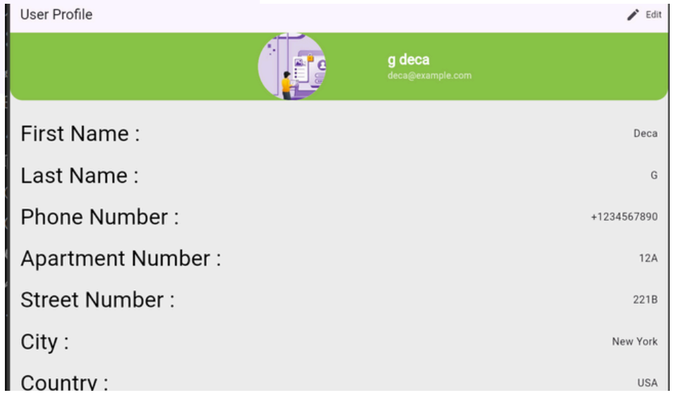
Implemented/ in work modules



AI reading of digital handwritten digit recognition with around 67% accuracy



Web Application Progress



HW and SW Distribution per team member

Mayssa

- Project coordinator
- Conveyor Belt
- Linear accurator implementation
- box assembly

Sultan

- Conveyor Belt (Panels)
- Web application

Esdras

- Software
- Web application

Nujhat

- Software (AI Implementation)
- Hardware (camera maintenance & synchronization)

Decaho

- Software (database management, implement the web application)
- Hardware integration (support)

Aya

- Hardware Specialist
- System Integration Specialist

Thanks for your attention