

# MFA Lock

James Kong, Yunus Kocaman, Danish Abbasi,  
Omorogieva Ogieva

# The Problem – Why MFA Lock?

## **Ever Been Locked Out?**

- The frustration of forgetting your key after a long day.
- Waiting endlessly for lockout assistance.

## **Traditional Keys: A Hassle**

- Easily lost, forgotten, or stolen.
- Can lead to security vulnerabilities.

## **The Need in Dorms (and beyond):**

- Desire for enhanced security for personal belongings.
- Demand for more convenient access solutions.



# Our Solution – Introducing MFA Lock

## **MFA Lock: Smart, Secure, Convenient Access**

- A cutting-edge multi-factor authentication system.
- Ensures you (and only you/trusted individuals) can access your room.

## **Keyless Freedom:**

- Multiple ways to unlock – no more sole reliance on physical keys.

## **Peace of Mind:**

- Enhanced security protocols to keep your space safe.
- Monitor and control access.

# Hardware Components

**Computing:** 2x Raspberry Pi, 2x Raspberry Pi Pico.

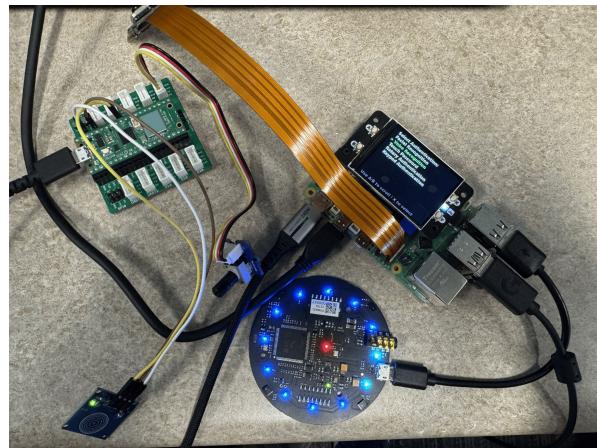
**Sensors:** Pi Camera, Microphone Array, Capacitive Touch Sensor, Rotary Angle Sensor.

**Display & Interaction:** 3.5" LCD Touchscreen.

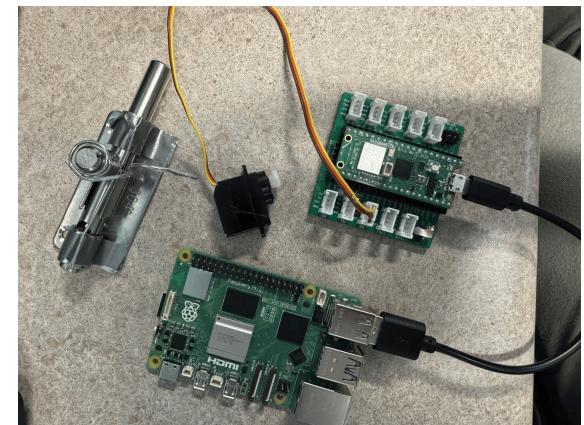
**Actuation:** Servo Motor.

**Connectivity:** Network, USB/Serial.

Raspberry PI with LCD display and all other sensors



Raspberry PI connected to Pico with servo motor and lock



# System Architecture Overview

## Distributed Design:

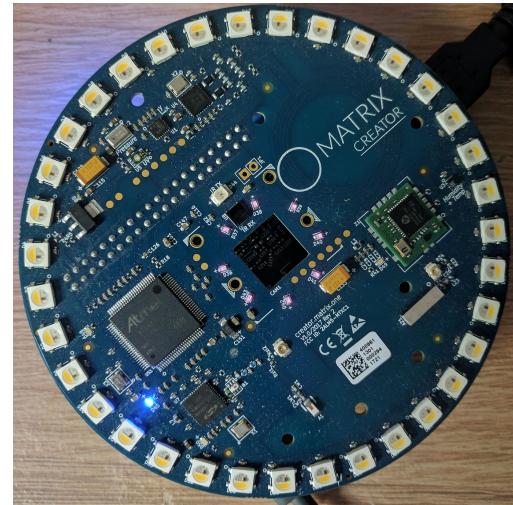
- **Raspberry Pi 1 (Sensor Hub & Web Server):**
  - Runs main Flask web application & UI.
  - Interfaces with Camera, Microphone, LCD Touchscreen.
  - Communicates with Pico 1 (Touch & Rotary sensors).
  - Processes authentication logic.
- **Raspberry Pi 2 (Listener & Actuator):**
  - Runs TCP listener script.
  - Receives auth success messages from Pi 1.
  - Commands Pico 2 to control the servo motor (lock).

# Authentication Methods – Part 1

**Face Recognition:** (via Camera) – How it works, known faces.

**Voice Recognition:** (via Microphone Array) – Vosk offline, challenge phrase.

**Gesture Unlocking:** (via Camera) – Brief mention of capability.

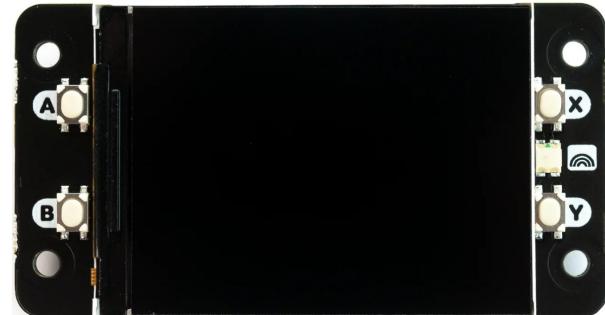
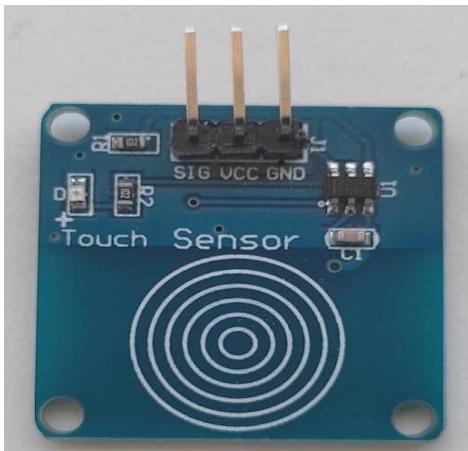


# Authentication Methods – Part 2

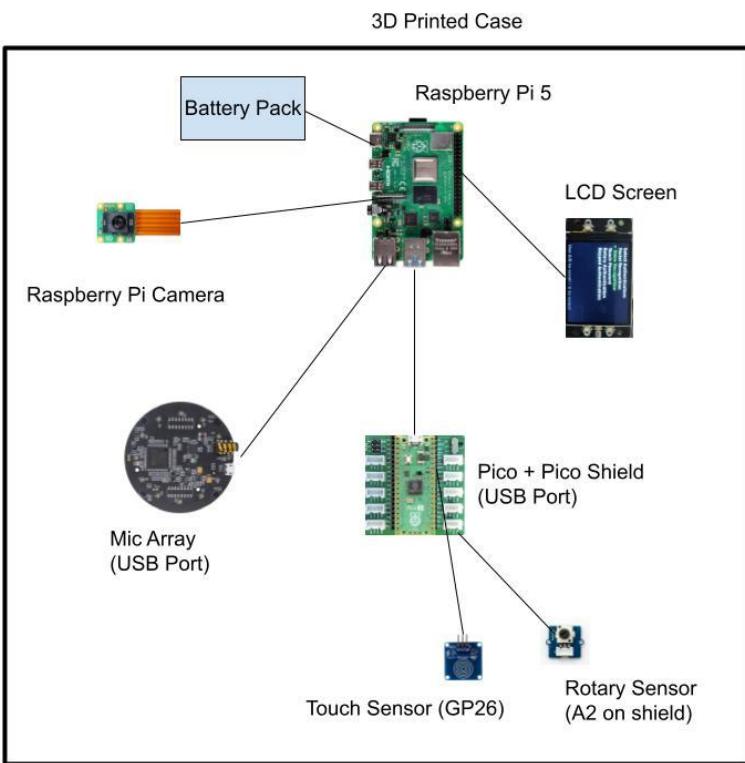
**Secret Tap Pattern:** (via Pico Touch Sensor) – Configurable tap/hold sequences.

**Rotary Angle Sequence:** (via Pico Rotary Sensor) – Color/angle patterns.

**Keypad Access:** (via Touchscreen Display) – PIN entry on LCD.



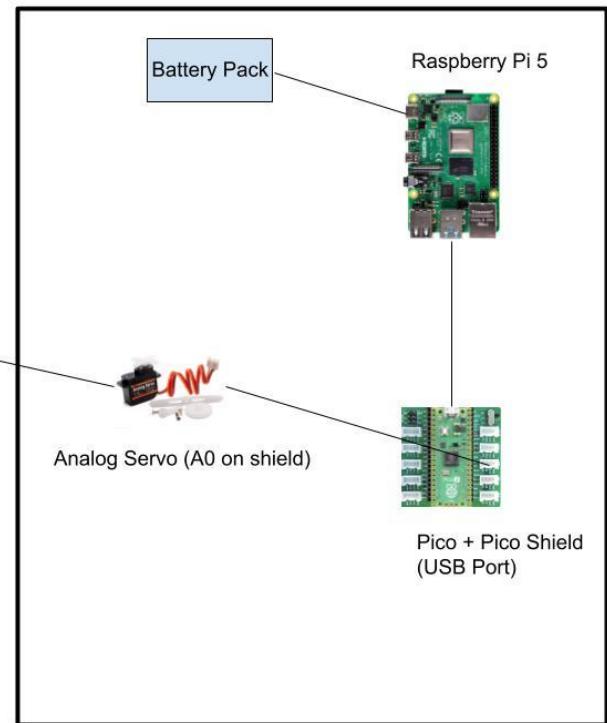
Two Raspberry Pi 5s that communicate over local network via Socket.IO



Door

Outside      Inside

All parts will simply be taped to the wall since case only required for outside security



# Web UI & Monitoring

## Centralized Control & Oversight:

- Flask-based web application.
- Accessible from any device on the same network.

## Key Features:

- **Real-time Monitoring:** See who's at your door (camera feed if implemented).
- **Live Status Updates:** Current auth mode, keypad entries, voice prompts displayed dynamically.
- **Access Logs:** Review historical entry attempts (success/failure).
- **Configuration:** Set up PINs, patterns, sequences, and other preferences.
- *(Future: Remote access grants, multiple user profiles).*

The screenshot displays the 'MFA Lock Security' web application interface. At the top, a dark header bar includes the logo, the title 'MFA Lock Security', and navigation links for 'Dashboard', 'How It Works', 'Auth Logs', 'Settings', and a green circular button labeled 'Pico Connected'. Below the header, a sub-header shows 'Current Mode: Idle' and lists authentication methods: 'Touch Pattern\* (Auto-activates)', 'Rotary Input\* (Auto-activates)', 'Voice Recognition', 'Facial Recognition', and 'Keypad'. The main content area is divided into two sections: 'Security Dashboard' and 'Live Authentication Events'. The 'Security Dashboard' section shows 'Showing data for: 5/7/2025' and two metrics: 'Successful Authentications' (27) and 'Failed Attempts' (49). The 'Live Authentication Events' section lists three recent events with failure status: '5/7/2025 07:38:25 PM Access denied: Incorrect touch pattern FAILURE', '5/7/2025 07:41:12 PM Access denied: Incorrect touch pattern FAILURE', and '5/7/2025 07:41:55 PM Access denied: Voice recognition timed out FAILURE'.

# Software Stack & Technologies

OS: Raspberry Pi OS (Linux), MicroPython (Picos).

Backend: Python, Flask, Flask-SocketIO, Pyserial.

Computer Vision: OpenCV, `face_recognition` library

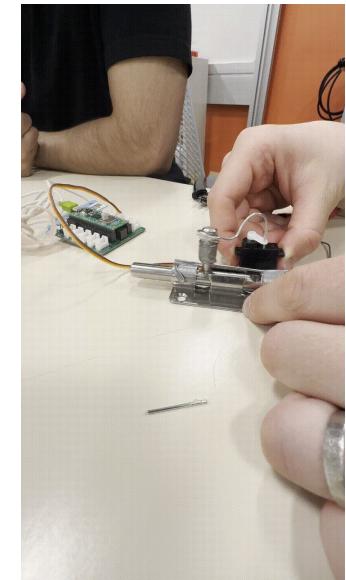
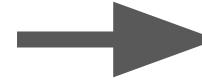
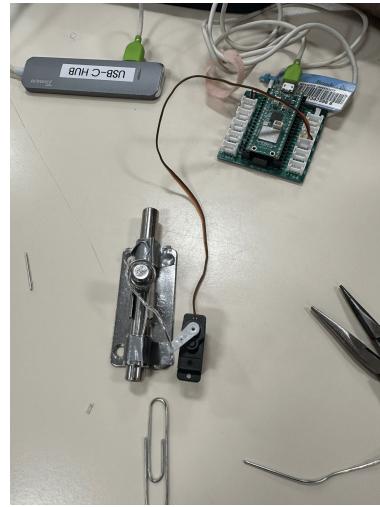
Voice Recognition: Vosk (offline model).

Communication: TCP/IP, WebSockets (Socket.IO), `mpremote`.

Frontend: HTML, CSS, JavaScript.

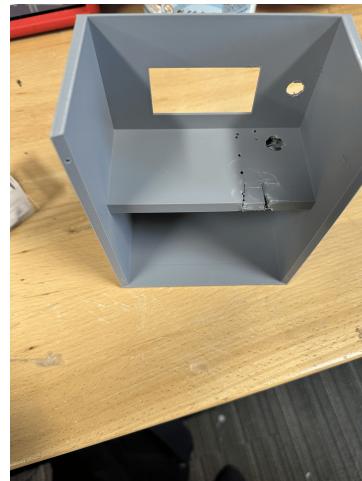
# Prototypes

# Servo Motor & Lock Prototypes



# MFALock Case v1

Flaws: No spacing for wiring inside case, too thick (too much infill used when printing), hole for LCD display was too small (was scaled down when printed)

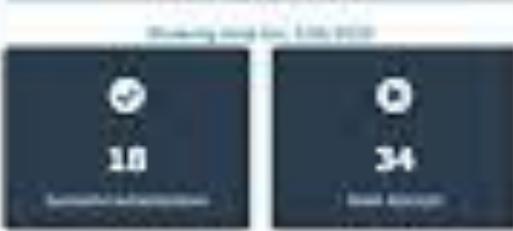


# MFALock Case v2



# Live Demo

<http://172.20.184.79:8080/dashboard>



SEARCH BY IP ADDRESS

SEARCH BY DATE

SEARCH BY LOGGED IN USER

SEARCH BY DEVICE

SEARCH BY LOCATION

SEARCH BY TIME

### Binary Authentication

Provide the location of the document library or folder.  
With 3 successful login tries to detect 1,000 of successful binary document login.



# Future Work & Potential Enhancements

## User Management & Sharing:

- Remotely grant temporary access to friends or roommates.
- Add support for multiple trusted users with personalized authentication methods.

## Feature Completion & Refinement:

- Finalize deployment of custom touch patterns to the Pico.
- Further optimize system performance and stability.

## Advanced Functionality:

- More sophisticated gesture recognition.
- Enhanced security features (e.g., intruder detection alerts, photo capture on failed attempts).

## Usability Improvements:

- Continued refinement of Web UI and LCD interface.

# Conclusion

## **MFA Lock: A Comprehensive Solution**

- Successfully addresses the common problems of key-based entry by providing multiple, convenient, and secure authentication methods.

## **Achieved Key Goals:**

- Enhanced user convenience through keyless operation.
- Significantly improved security for personal spaces.

## **A Robust and Extensible Platform:**

- Demonstrates effective integration of diverse hardware and software technologies.
- Provides a solid foundation for future enhancements.

# Thank You & Q&A