AIFRD (AI Face Recognition Door)

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1. Introduction

1.1 Background

Currently, the traditional physical locks are too cumbersome to use and easy to pick. Keys for said locks are also very easy to lose. The current fingerprint and digital locks are either very expensive or unreliable, and are not a viable option for home security. Face Recognition locks are ideal for security, surveillance and convenience. Current so-called “smart locks” are extremely easy to hack[1], with digital authentication methods completely nonexistent.

1.2 Rationale and Objectives

The objective of this is to design a working lock that relies on face recognition to ensure that security of the property is maintained while still providing convenience. We will create an affordable lock that is safe and secure, while still being convenient for everyone. This will allow offices and schools to have a more efficient entrance through reducing manpower and increasing entry speed and allow homes to be entered with better convenience.

1.3 Significance of project

We hope to improve home, office and school security and convenience by providing an affordable, convenient and secure solution to the age-old problem of securing your property through newer technologies that are available to make our daily lives more convenient.

1.4 Target Audience and Project Scope

Our target audience are businesses, schools and home owners who are interested in having a quick and easy solution to protect their home from any potential threats. As outlined above, our project scope is to create a secure and convenient lock.

2. Literature Review

There are several problems with smart locks. They are expensive, they can be exploited, and can create logjams as only one face can be entered at once.

Nonetheless, it brings us convenience and security, as it can alert us if intruders are present and also speeds up the unlocking of the doors, as you no longer need to unlock them using keys.

> Investigations have found that smart door locks have higher safety risks, especially in their remote control and facial recognition functions, according to a statement by the State Administration for Market Regulation on Monday.
>
> Quality checks by the administration found that keyless locks are prone to safety problems related to passwords, anti-electromagnetic interference, and fingerprint recognition.
>
> Consumers are advised to purchase smart door locks at reputable larger stores, not to activate the face recognition or remote access control functions, and to choose products with input error alarm and anti-vandal alarm functions, the statement said.
>
> Consumers should set up two-factor authentication, such as using a password and a fingerprint together as a key, the statement said.

Taken from: http://www.chinadaily.com.cn/a/201810/31/WS5bd913dfa310eff3032859ea.html [4]

As we can see in the snapshot above, these locks can be unsafe, depending on the quality of the product. Some even say that face recognition should be disabled [6]. They cite reasons such as it being an infringement of privacy and discrimincatory against minorities.

There are many face recognition algorithms such as eigenfaces. We have used a HOG algorithm as it is reliable [5].

Figure 2.1: Examples of similar products

3. Study and Methodology

3.1 Timeline

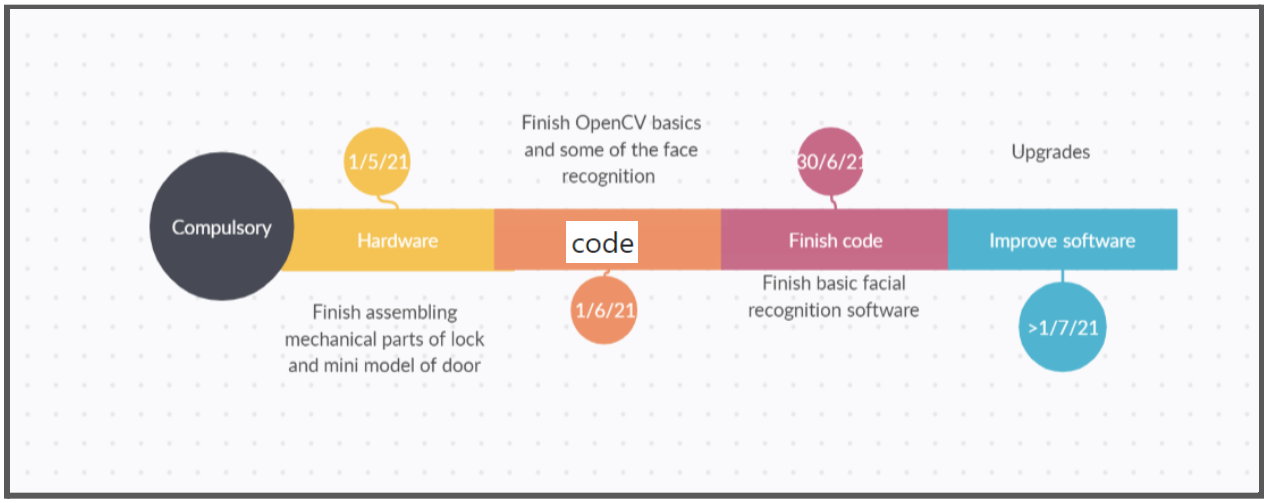
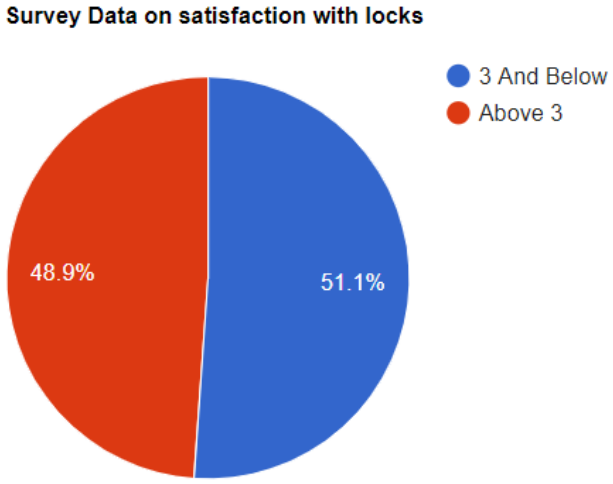
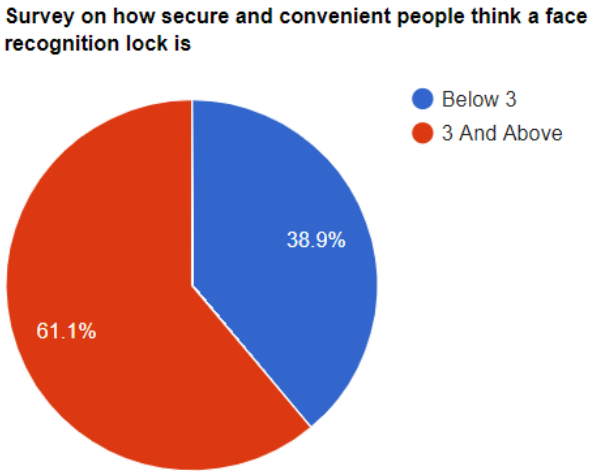


Figure 3.1: Timeline

3.2 Survey





Survey on how relevant and helpful people think face recognition will be

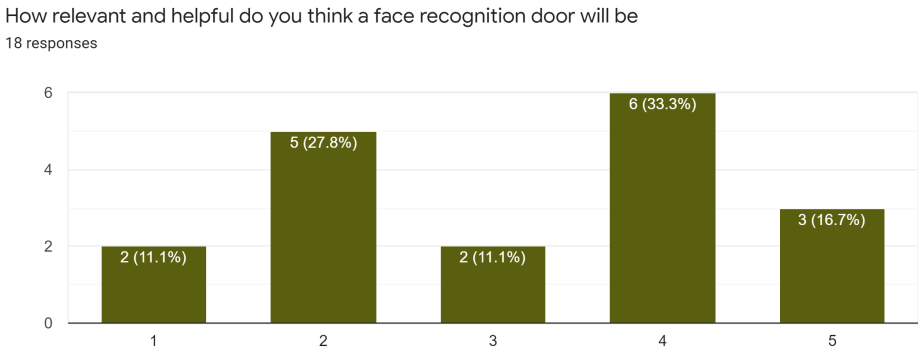


Figure 3.2.1, 3.2.2, 3.2.3 Survey data

We randomly picked people to answer to get accurate results. In total, around 20 people responded to our survey. They were asked to score their responses on a scale of 1 to 5, with 1 being the worst and 5 being the best. The results show that a majority of people are not satisfied with normal locks and confident about face recognition locks. They also show that a majority of people think that a face recognition door would indeed be relevant and helpful. Therefore, we can conclude that a face recognition door is something people want and thereby worth developing.

3.3 Equipment Used

- Raspberry Pi 4B
- Raspberry Pi Camera v2
- Servo Motor
- Screws
- Wires
- Plastic plates
- LCD screen

3.4 Work distribution

Zhao Jianzhi - Main Programmer

James Lim - Research and writing

Cai Zhihong - Slides

Guo Junhong - Slides and time tracking

4. Outcomes, Analysis & Discussion

4.1 System Design

Our product uses a raspberry pi 4b+, A servo motor, camera, screws, plastic, cardboard and wires. These are assembled into a box and a door that acts as a face recognition door.

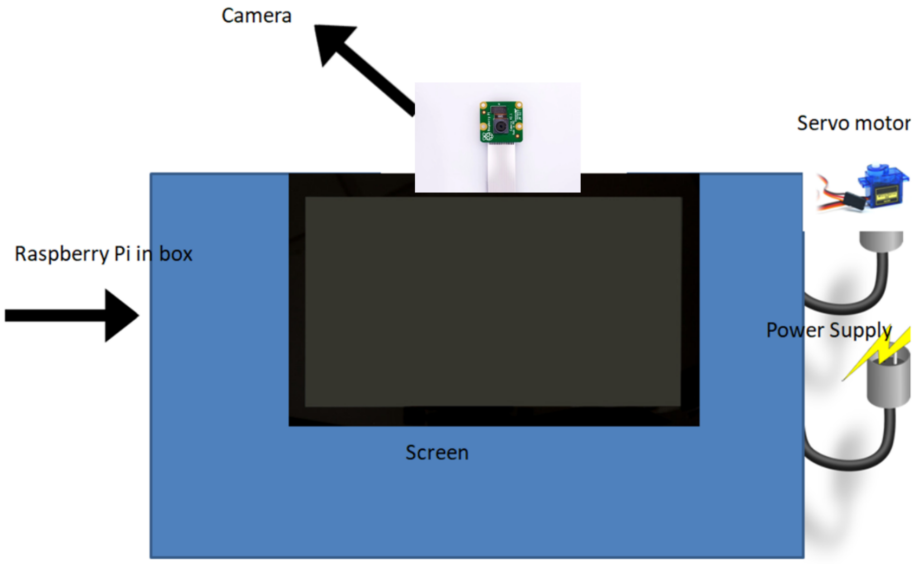


Figure 4.1: System Architecture

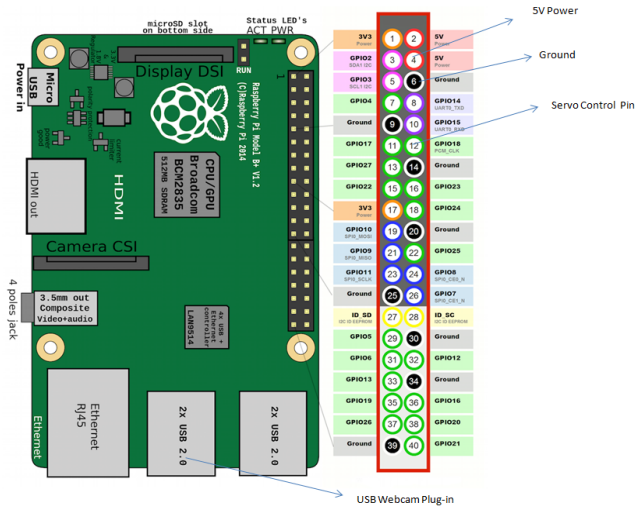


Table 4.1: Pin Connections And USB Plugin

4.2 System Implementation

First, you need to train the model with a photo of your face. The trained model is then saved to a xml file

The main training code is shown below :

```
for (i, imagePath) in enumerate(imagePaths):
    # extract the person name from the image path
    print("[INFO] processing image {}/{}".format(i + 1,
        len(imagePaths)))
    name = imagePath.split(os.path.sep)[-2]

    # load the input image and convert it from RGB (OpenCV ordering)
    # to dlib ordering (RGB)
    image = cv2.imread(imagePath)
    rgb = cv2.cvtColor(image, cv2.COLOR_BGR2RGB)

    # detect the (x, y)-coordinates of the bounding boxes
    # corresponding to each face in the input image
    boxes = face_recognition.face_locations(rgb,
        model="hog")

    # compute the facial embedding for the face
    encodings = face_recognition.face_encodings(rgb, boxes)

    # loop over the encodings
    for encoding in encodings:
        # add each encoding + name to our set of known names and
        # encodings
        knownEncodings.append(encoding)
        knownNames.append(name)
```

We have used a HOG algorithm for our face recognition and used ChangeDutyCycle to control the motors. The Raspberry Pi first Captures the frame from the camera and tries to recognise a face. After that, it matches it to the list of approved names. The pictures are stored in their respective folders for recognized people and the unauthorized folder for unrecognized people. If

there is a match, the variable should_door_open is changed to true. If the face is not recognized, should_door_open becomes false. If should_door_open is true and the delay from the time the door last opened is greater than 5 seconds, the door will open. If the face is not recognized or there is no face and the door has opened for more than 5 seconds then the door will close and should_door_open will become false.

```
        # check to see if we have found a match
        if True in matches:
            # find the indexes of all matched faces then initialize a
            # dictionary to count the total number of times each face
            # was matched
            matchedIdxs = [i for (i, b) in enumerate(matches) if b]
            counts = {}


            # loop over the matched indexes and maintain a count for
            # each recognized face face
            for i in matchedIdxs:
                name = data["names"][i]
                counts[name] = counts.get(name, 0) + 1

            # determine the recognized face with the largest number
            # of votes (note: in the event of an unlikely tie Python
            # will select first entry in the dictionary)
            name = max(counts, key=counts.get)
            date = datetime.datetime.now().strftime('%m-%d-%Y_%H.%M.%S')
            img_name = "entrylog/"+ name +"/image_{}.jpg".format(date)
            cv2.imwrite(img_name, frame)

            #If someone in your dataset is identified, print their name on the screen
            if currentname != name:
                currentname = name
                print(currentname)
            should_door_open = True
```

```
    else:
        name = 'Unauthorized'
        date = datetime.datetime.now().strftime('%m-%d-%Y_%H.%M.%S')
        img_name = "entrylog/"+ name +"/image_{}.jpg".format(date)
        cv2.imwrite(img_name, frame)
        should_door_open = False
    # update the list of names
    names.append(name)
```

```
if should_door_open is True:
    if is_door_open is False:
        p.ChangeDutyCycle(2)
        is_door_open = True
    last_opened_time = time.time()
elif is_door_open is True and (time.time() - last_opened_time) > 5:
    p.ChangeDutyCycle(7)
    is_door_open = False
```

Figure 4.3.1, 4.3.2 and 4.3.3: Parts Of Main Program

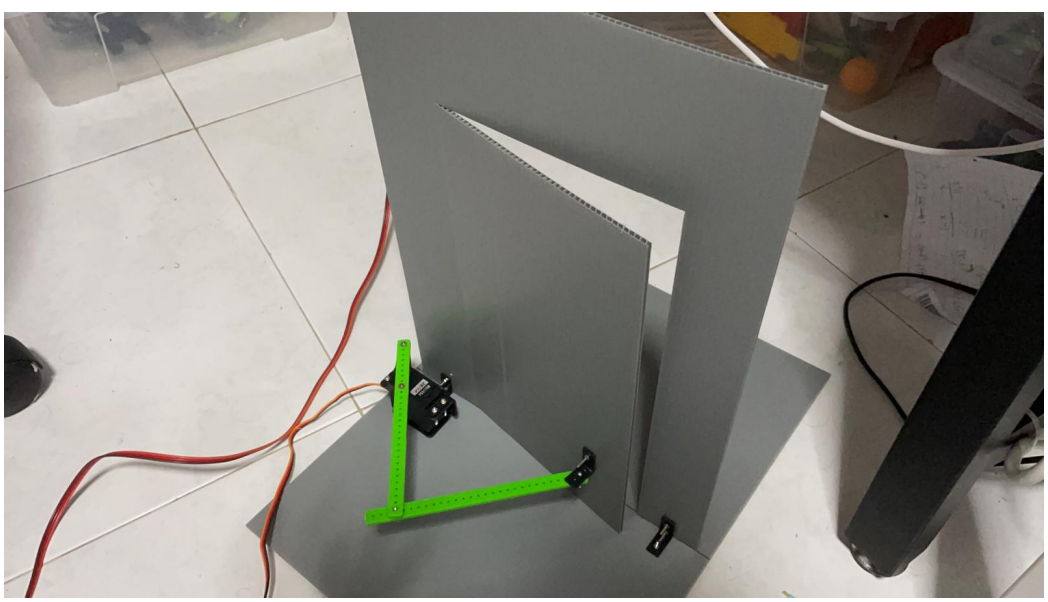


Figure 4.5: Door mechanism

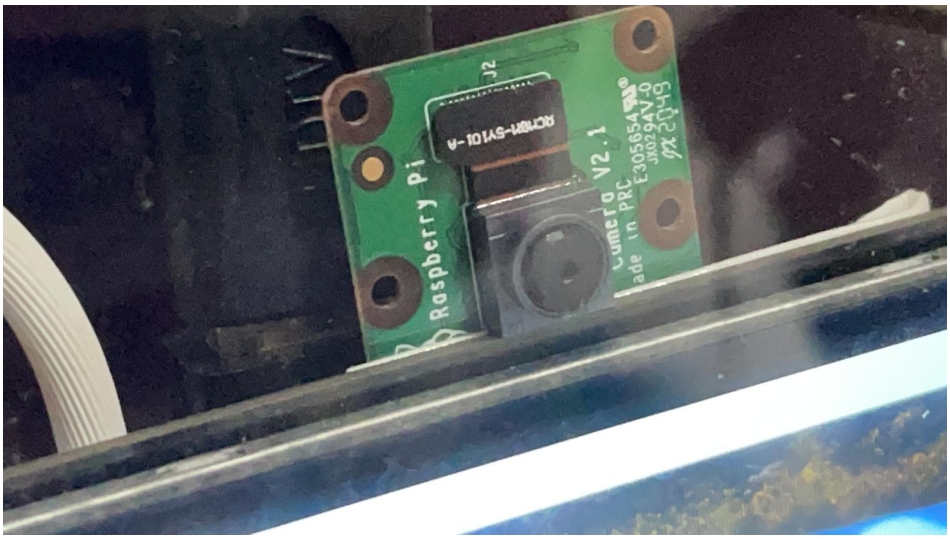


Figure 4.6: Camera

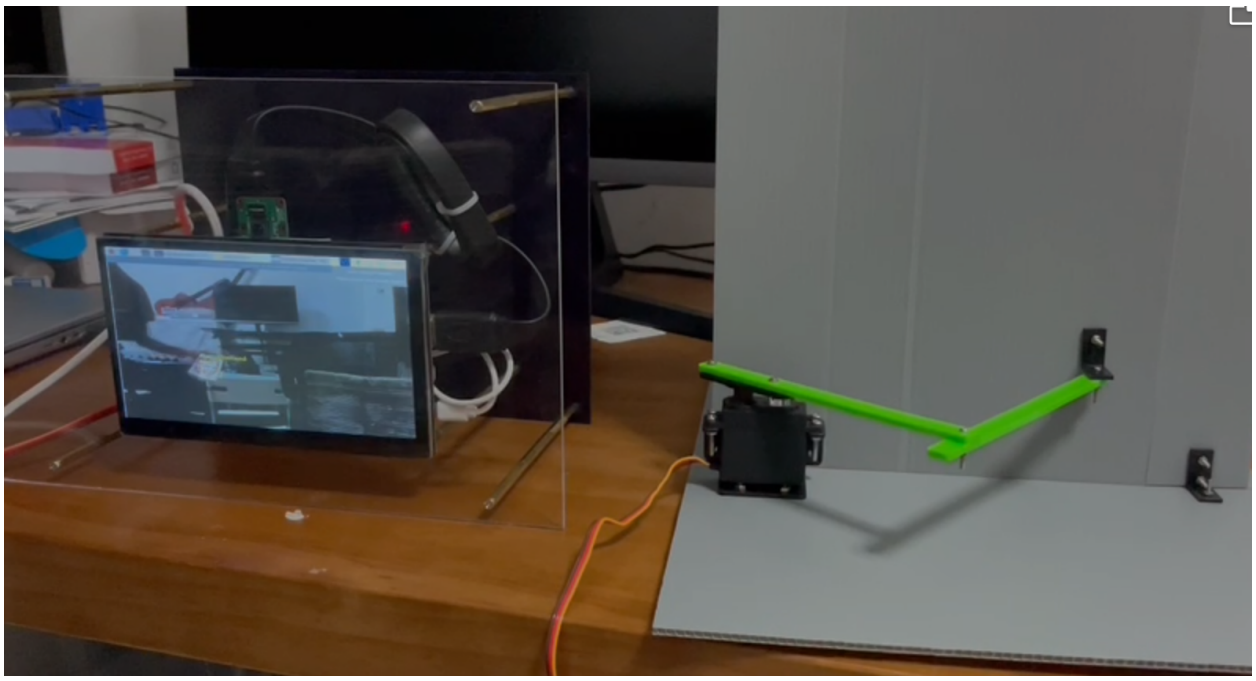


Figure 4.7; Door + Camera and raspberry pi (The complete product)

5. Future Developments

We plan to add many improvements to our gadget in the future which we were not able to implement due to a lack of time.

The first improvement we would like to add is better face recognition algorithms. Our face recognition training model is not as advanced as more recent algorithms and we would like to change it in the future. This means that our lock can still be fooled, and this can cause a decline in safety.

The second improvement we would add is a more secure lock and better design. Our current lock is not very secure and can be easily replaced and our design is very bland.

The third improvement we will add is cloud access. Currently, the only way to get access to the raspberry pi is to use a VNC. We hope to be able to develop something to allow people to access the camera of the lock remotely.

6. Conclusion

6.1 Reflections and Learning points

The learning point that we took away was that we needed to adapt quickly to changes. We learnt that change was the only constant, and that being able to adapt to changes quickly was crucial in us being able to get things done on time. We were not able to meet up in person with our groupmates and mentor to build the lock and discuss issues. Instead we had to communicate through texting and google meet which caused delays between responses as we do not check our messages that often. Another example, due to the Covid-19 pandemic, the parts for the gadget which we ordered were delayed and arrived late. This meant that we had to build the gadget on a time constraint. However, we still managed to build the gadget on time, showing that we were able adapt to changes

6.2 Summary

We have successfully managed to build a lock which is activated via face recognition. The only part which we were unable to finish was the cloud access, due to time constraints caused by the COVID-19 pandemic. We will continue to try to improve and learn along the way.

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