Facial Recognition Lockbox

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Background

- In 2021, an estimated $870.8 billion dollars were spent on e-commerce sales, increasing by 14.2 percent from the previous year.
- 40% of Americans have been the victims of package theft and more than 60% know somebody who has fallen victim
- Relevant Lockboxes, price range between $300-$1000+ dollars.
- These Lockboxes range from having none to several smart technologies features.
- None including Facial Recognition.

Relevant Solutions & Comparisons

Eufy Security SmartDrop

- Can be opened via PIN or with a mobile app
- Two-way communication through box and app
- Battery powered

Cost: $400

Yale Smart Delivery Box

- Can be opened via PIN or with a mobile app
- Battery Powered

Cost: $300

Motivation

- Reduce the amount of at home package thefts, deterring porch pirates.
- Design a multipurpose Lockbox; food, packages, mail.
- Create a efficient and cost effective high tech Lockbox.
- Learn new skill for future endeavors.

Goals and Objectives

- Container to prevent package theft with added security
- Cloud storage to keep account information secure
- Keypad for interaction between user and lockbox
- Microcontroller controls microprocessor
- Mobile application to manage accounts, send images, and receive 6 digit passcode
- 2 factor authentication with 6 digit passcode and facial recognition

Features

- Email Verification

- Speaker to aid in user interaction with Lockbox

How does our solution compare to existing ones?

- Facial recognition decreases user friction
- Using outlet power connection is more available, easier, and more efficient than using battery power
- Specifically implementing elements for keeping food safe while also being able to accept non-food deliveries
- Lower overall cost

Specifications

Component	Requirement Specifications
Software	The AI facial recognition software must be able to identify a user with 95% accuracy
Software	The AI facial recognition software must have an execution process between 3 to 7 seconds
User Interface	The user interface must have an execution time of 1-3 seconds to upload an image to the cloud service
Main Unit	The system will have a 6-digit code lock, as a form of 2 factor authentication.
Main Unit	Main Unit must notify user of next needed action or if something went wrong.
Hardware	The locking mechanism must be able to withstand 150 pounds of force.
Cost	Cost of main unit, hardware, and cloud service should not exceed $200

Relevant Standards

Lock Security

- ANSI Grade 3; Must be able to withstand:
  - 200,000 cycles
  - 2 door strikes
  - 150 pounds of weight
  - 2 hammer strikes
- Generally used on residential door locks, which is ideal as a deterrent but still weak enough to be opened forcefully in an emergency
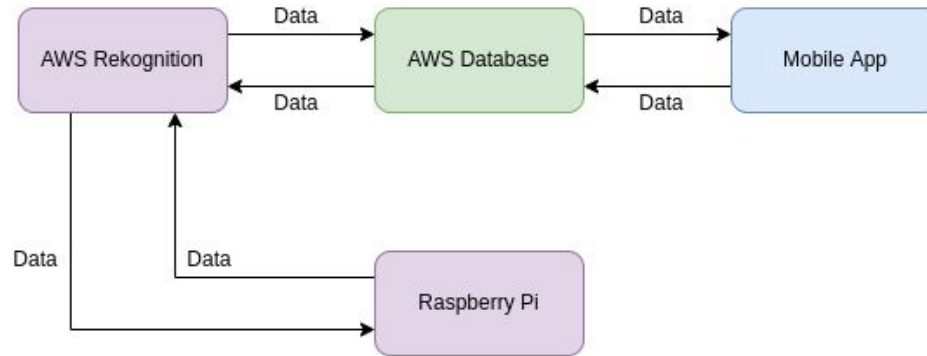
Itemized Budget

Item	Price
Microprocessor	$FREE
Lockbox	$75
Camera module	~$15
Electronic latch	$10
Amazon Web Services Server	~$0.016 per hour
Power supply	~$20
Total	**~$120**

Hardware Block Diagram

Lock Box
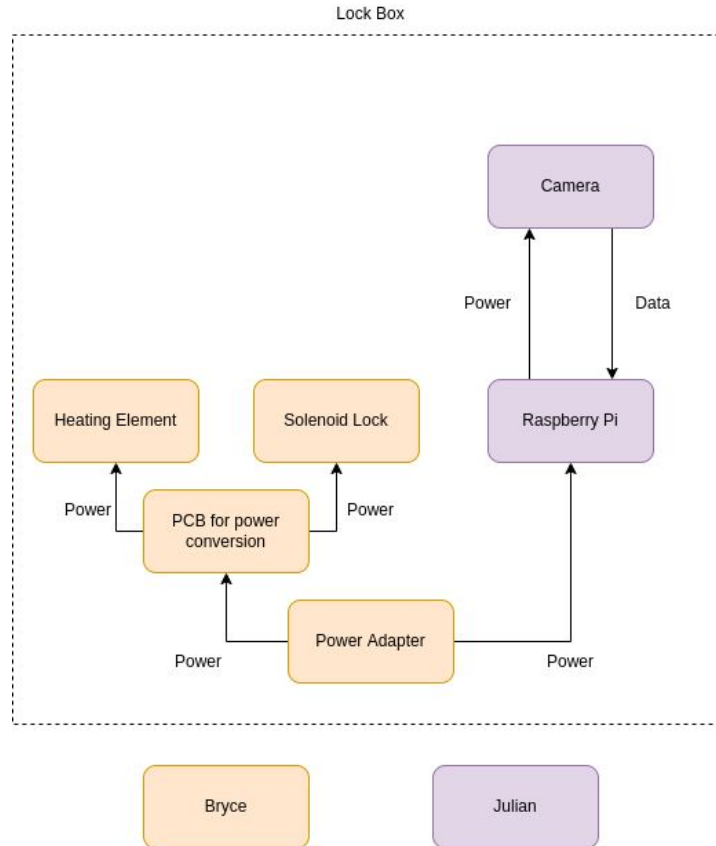
Software Block Diagram

ER Diagram
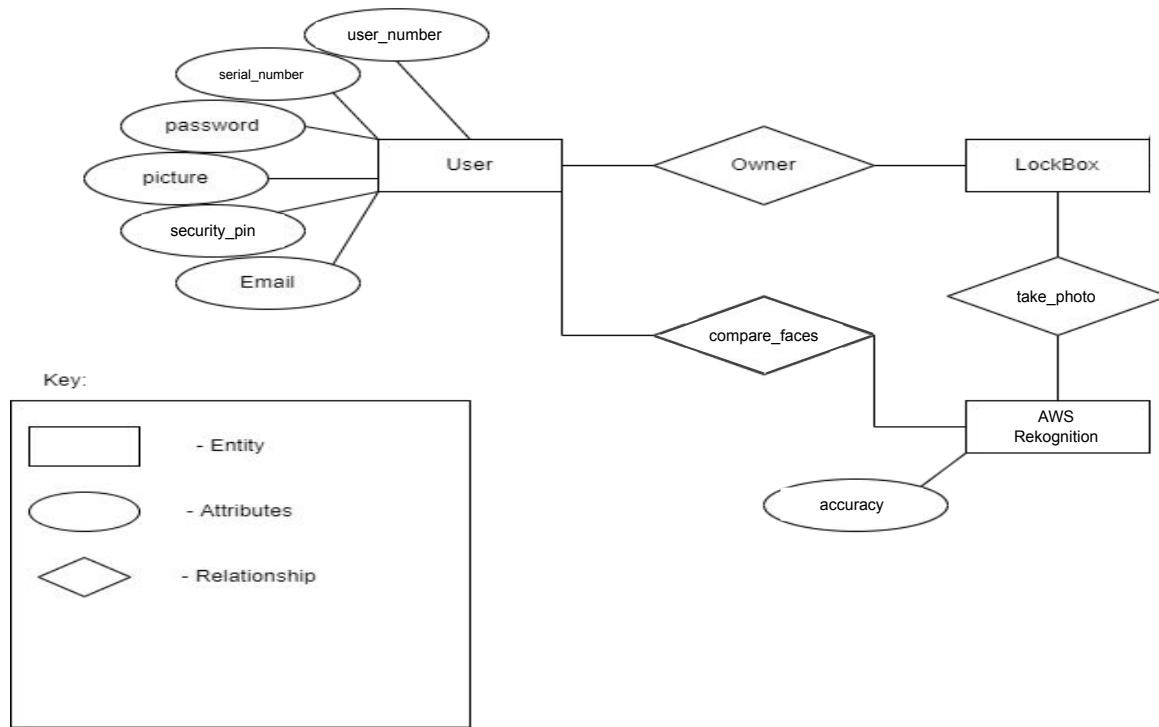
Amazon Web Services

- AWS Rekognition will be used for artificial intelligence model

- AWS S3 will be used for storing user data

- AWS will keep all of the data needed for identifying users

- AWS allows us to reduce the hardware requirements of the lock box, as well as our user's cell phones

- AWS is the only DoD approved cloud service, ensuring security
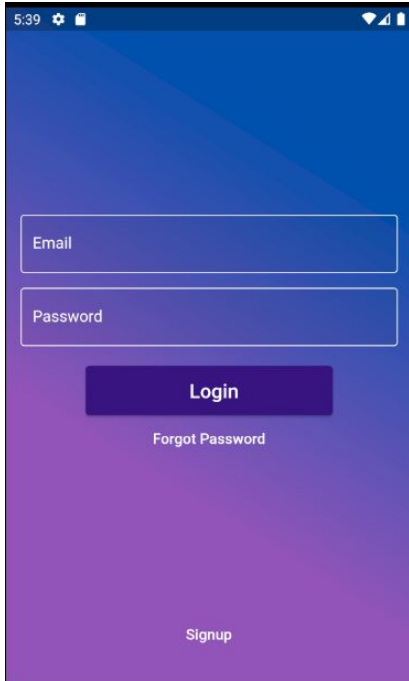
- AWS has the ability to scale with the program, as user data increases.

Raspberry Pi Scripts

- Used Python packages to receive input and send output to microcontroller, make AWS API calls, and generate text-to-speech
- User is instructed on how to interact with the Pi through the text-to-speech
- User can interact with Python script via keyboard for pin entry and keystroke for taking the photo
- Both the 6 digit pin and photo must match what is associate with their account in order to gain access to the interior of the box
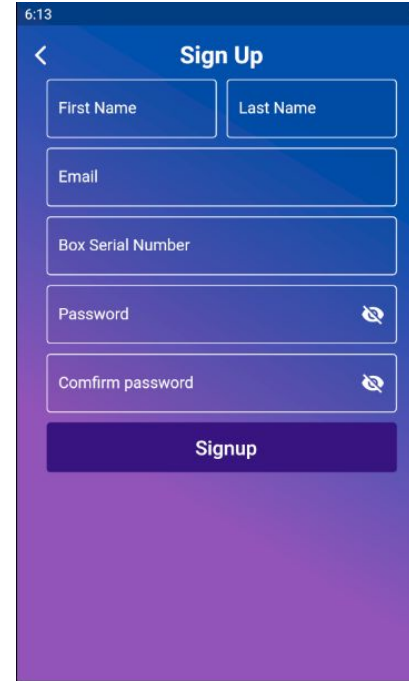
User Interface/Mobile App

- Here are the 3 immediately accessible pages
- For signup, password has to be strong and meet certain specifications (8 characters long, at least 1: capital letter, lowercase letter, number, and special character
- Signup requires all fields be filled
- Both Signup and Password Recovery send confirmation emails for user for added security
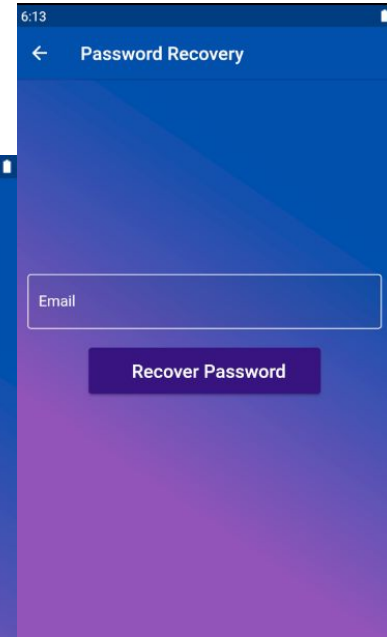
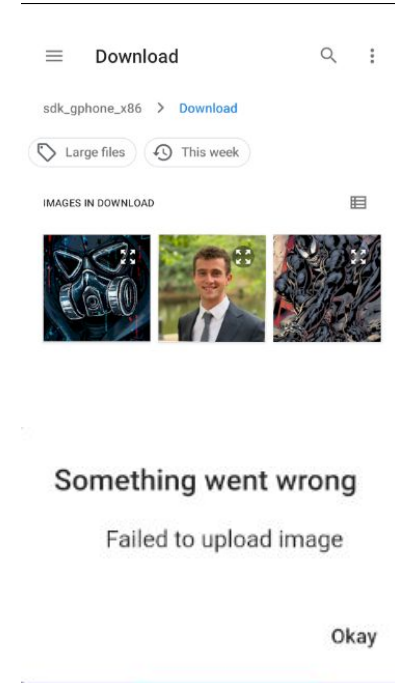Login page

Signup Page

Password Recovery Page
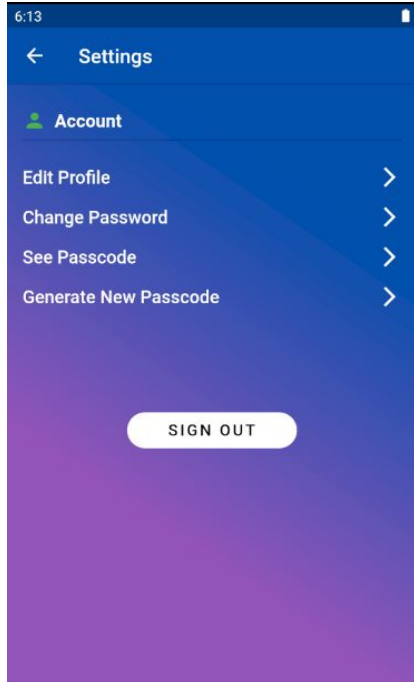
User Interface/Mobile App (cont.)
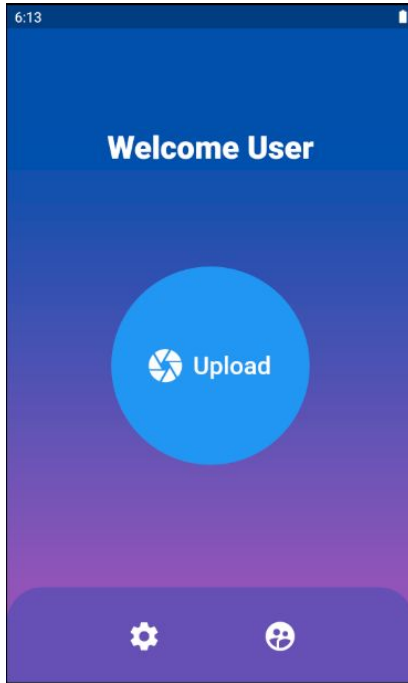

- User home page (as seen on left)
  - 3 buttons
    - Upload
    - Settings
    - About Us
- Upload button will take you to your gallery
- Failure to upload image will result in a dialog box appearing
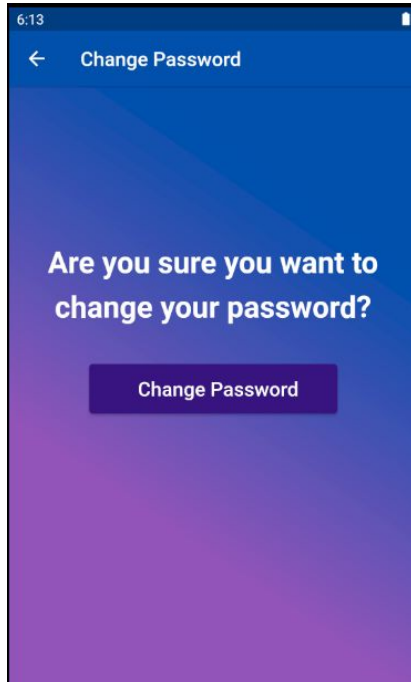
# User Interface/Mobile App (cont.)

- Settings Page
  - Allows user to:
    - Edit Profile (change name and email)
    - Change password
    - See current passcode
    - Generate a new passcode
- The Profile Page
  - User's account information automatically loaded

Close
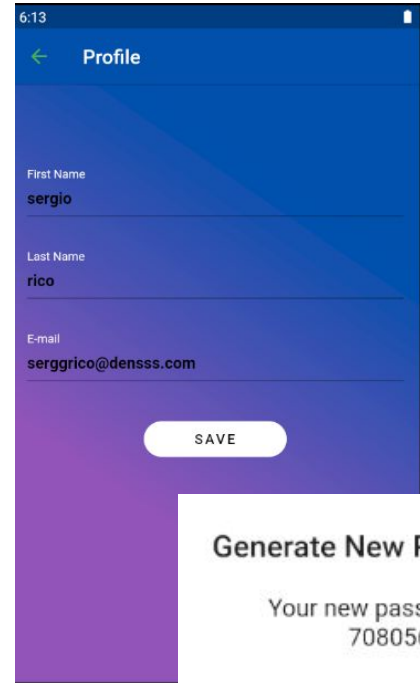
User Interface/Mobile App (cont.)

- Change password makes sure user wants to change your password before continuing
    - Email confirmation will also be sent
- About Us page seen on right
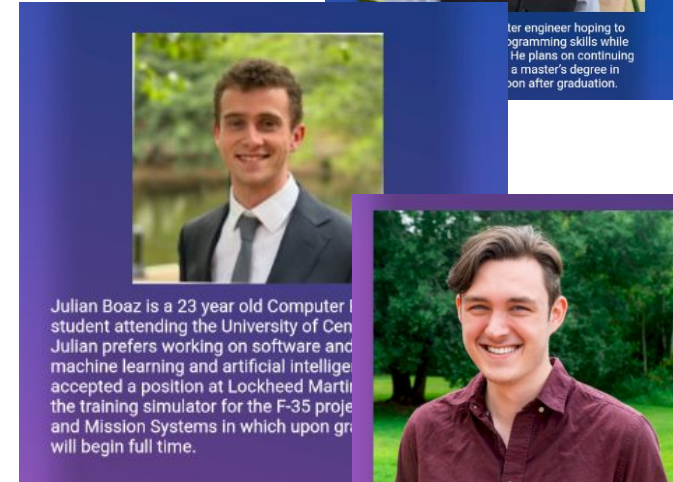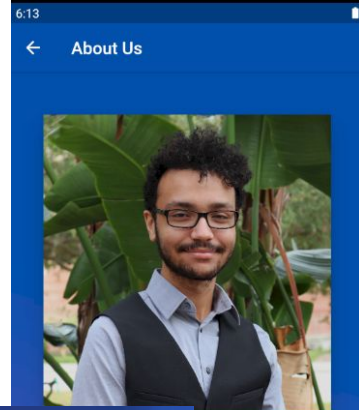
User Interface/Mobile App (cont.) – How it's all done
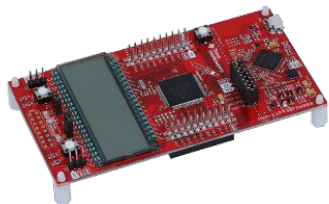


```dart
Future<void> login() async {
//var res;
        Amplify.Auth.signOut();
        //Amplify.Auth.signOut();
        x = EmailController.text;
            try{
                final res = await Amplify.Auth.signIn(username: EmailController.text, password: PassController.text);
                _isSignedIn = res.isSignedIn;
            }
            catch (e){
                showDialog(
        context: context,
        builder: (BuildContext context){
```

```dart
final pickedFile = await picker.getImage(source: ImageSource.gallery);

    try {
        final UploadFileResult result = await Amplify.Storage.uploadFile(
            local: file,
            key: key,
            onProgress: (progress) {
                print('Fraction completed: ${progress.getFractionCompleted()}');
            },
        );
        print('Successfully uploaded image: ${result.key}');
    } on StorageException catch (e) {
        print('Error uploading image: $e');
    }
```

AWS Amplify

- aboutus.dart
- amplifyconfiguration.dart
- changePass.dart
- confirm_reset.dart
- constants.dart
- entry.dart
- forgot.dart
- generated_plugin_registrant.dart
- history.dart
- home.dart
- inBetweenCPass.dart
- login.dart
- main.dart
- profile.dart
- settings.dart
- signup.dart
- upload.dart
- verification.dart
- verification2.dart

Hardware Design

Circuit to convert power for MCU & solenoid switching

Raspberry Pi to communicate with Facial Recognition algorithm and activate lock and heater
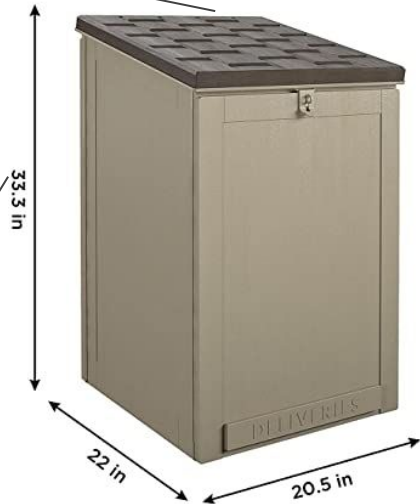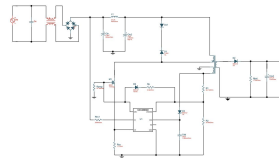
Microcontroller to trigger peripherals and consolidate signals to/from microprocessor

Power connection for Raspberry Pi, heater, and solenoid

33.3 in

22 in

20.5 in

53 in

13mm / 0.51"

16mm /0.63 "

20mm /0.79"

Solenoid lock controlled by processor

Original PCB Design vs Final Implementation
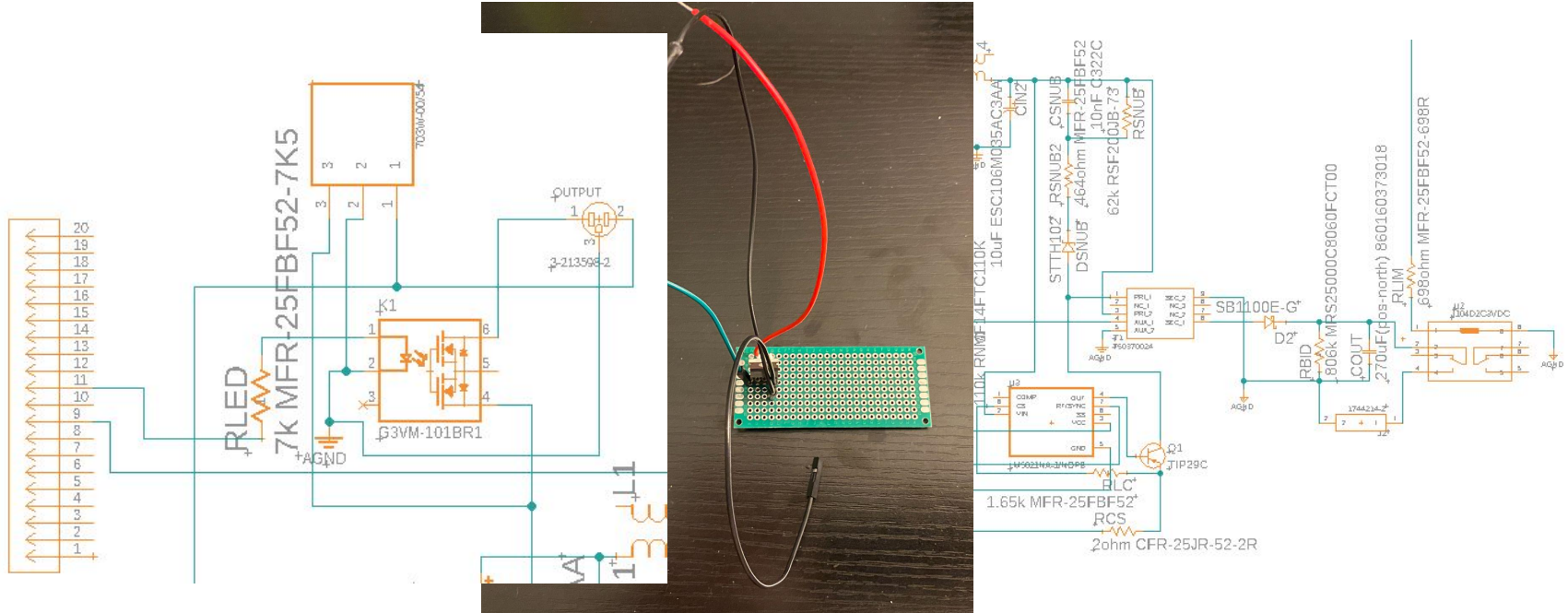
Why use a solenoid for the locking mechanism?

- Easier to implement than repurposing other electronic locks (e.g. door locks)
- Requires a relatively low amount of power
- Only needs one GPIO pin on the processor, leaving more pins open for other uses

13mm / 0.51"

16mm /0.63 "

20mm /0.79"

Single-Board Computers

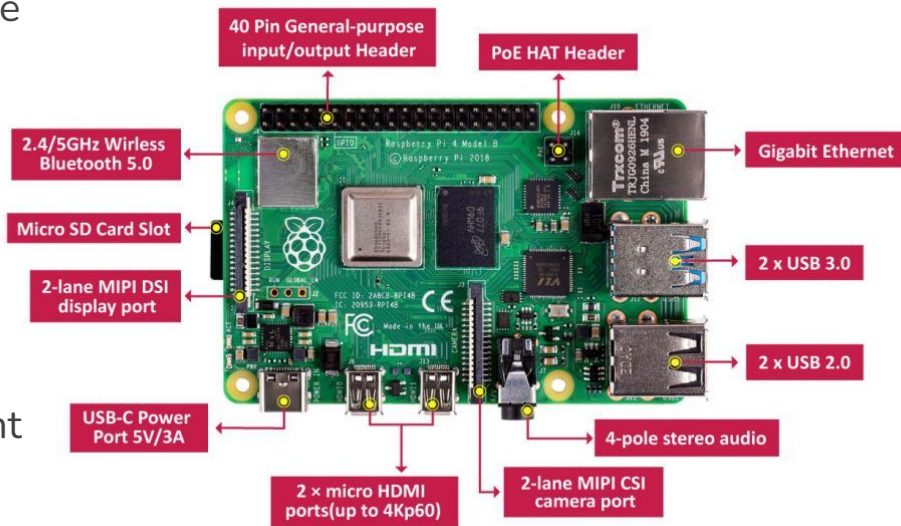| Controller	CPU	RAM	Speed	GPIO	SD card support	Native USB	Camera support	Cost
Raspberry Pi 4 (a)	Quad-core Cortex-A72	4 GB	1.5GHz	40-pin	Yes	Yes	Yes	~$100-$120
UDOO BOLT V3	AMD Ryze Embedded V1202b Dual Core	2x Ddr4 Dual-channel 64-bit	2.3ghz	40-pin	Yes	Yes	Yes	~$450.00
NVIDIA Jetson Nano (c)	Quad-core ARM A57	4 GB	1.43 GHz	40-pin	Yes	Yes	Yes	~$350 Dollars

a.

b.

c.

Why the Raspberry Pi?

- Meets hardware specifications

- Compatible with other hardware and software requirements

- Group has experience using

- With chip shortage and supply chain stress, Raspberry pi was already available

- Applicable with several different cameras, quality depending on the camera

40 Pin General-purpose input/output Header

PoE HAT Header

2.4/5GHz Wirless Bluetooth 5.0

Gigabit Ethernet

Micro SD Card Slot

2-lane MIPI DSI display port

2 x USB 3.0

2 x USB 2.0

USB-C Power Port 5V/3A

4-pole stereo audio

2 × micro HDMI ports(up to 4Kp60)

2-lane MIPI CSI camera port

Microcontrollers

Controller	Microcontroller	Memory	Speed	GPIO	Power	USB	Price
MSP430-FR6989 (a)	MSP430	2 KB	16MHz	83-pin	1.8V ~ 3.6V	No	~$30
Arduino UNO R3 (b)	ATmega328P	2KB SRAM / 32 KB Flash	16MHz	39-pin	5V	Yes	~$30
STM8S103F3 (c)	STM8 core	1 Kb	16 MHz	32-pin	2.95 - 5.5 V	Yes	<$10
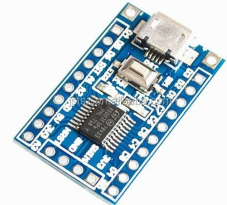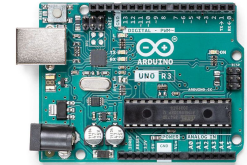
Testing

- User registering account and uploading picture to database.

- Interaction with microcontroller triggering recognition script on microprocessor.

- Camera on lockbox being able to take picture of user, and AI accurately analyzing picture to picture in database.

- AI outputting either a yes or no to unlock device, sending signal to microcontroller to unlock solenoid locking mechanism.

Software Challenges

- Connecting the mobile application to AWS (unsupported features for app build, trouble connecting to correct userpool)

- Due to using the Raspberry Pi, we have to use an unsupported version of AWS CLI

- AWS account was compromised due to setting up permissions incorrectly

- Package management for Python scripts (text-to-speech and microcontroller interaction packages)

Hardware Challenges

- During testing, we found that our version I board design, a trace between terminals of the diode rectifier shorted.

- In version II of our board, another trace on the board short-circuited in the same location; this connection was removed to a vector board where the same problem was had. This problem was bypassed for testing by using an existing power conversion circuit.

- While trying to connect the MSP and Pi together, our group had difficulties in getting the signal to be sent and read by each device.

- Due to time constraints, the heating element was removed from the design.
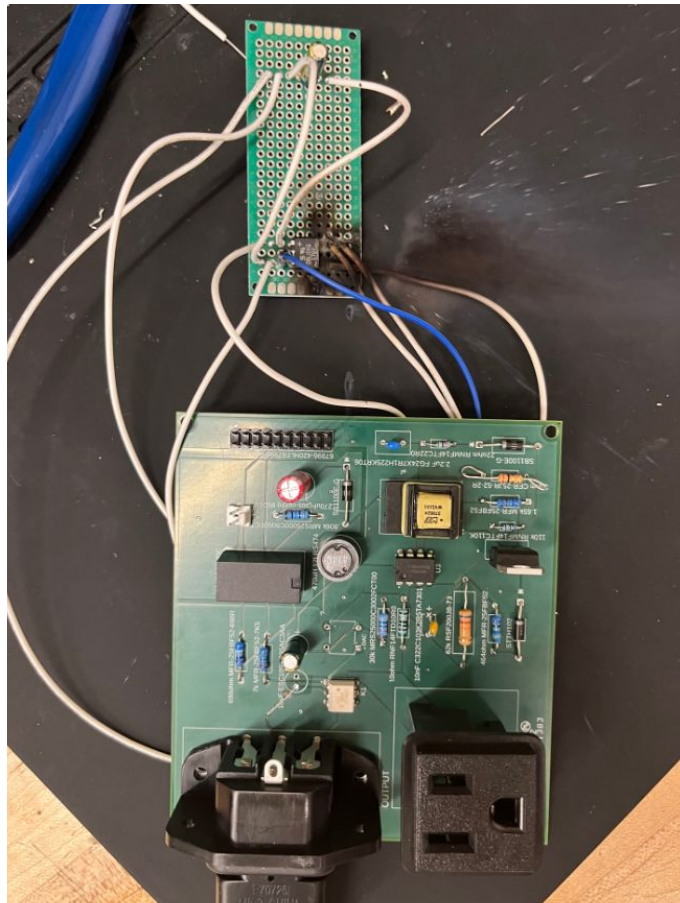
Relevant Standards

Food Heating

- The FDA recommends hot foods be held at 120-140° F
- Safe holding time at outdoor temperature is about one hour; for holding times longer than this, a heating element will be used
- An adjustable heating element will allow the user to set the desired warming temperature with a dial; the element pictured is capable of heating up to 200° F