Facial Recognition Lockbox

Group 4
Ryan Wiegman, Cpe
Julian Boaz, Cpe
Che’ Baptiste, Cpe
Bryce Dere, EE

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.

Objectives and Goals

- Automate the use of a lockbox
- Integrated mobile application
- Easy access database with mass storage
- Implement heating component
- Cost effective
- Outlet powered
- Unlockable with facial recognition AI program
- Backup keypad for unlocking when facial recognition fails

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

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

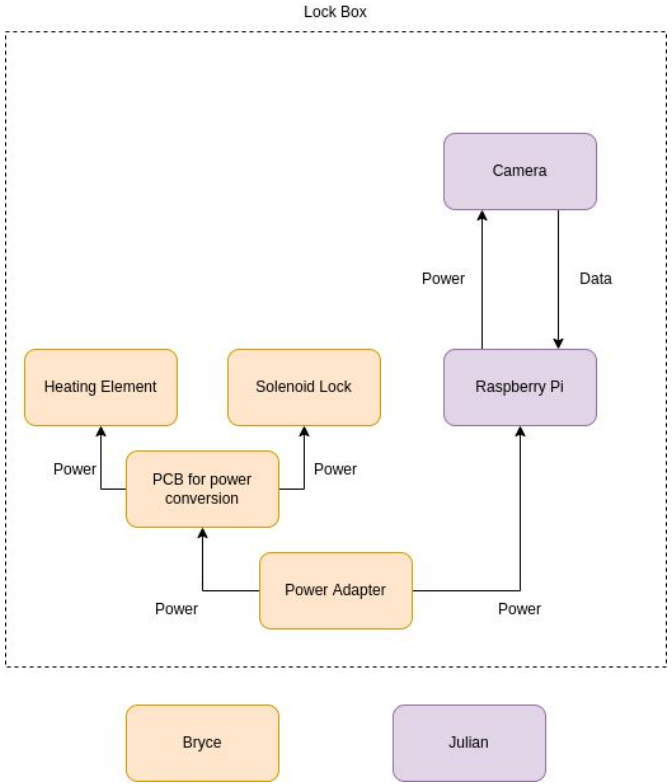
Specifications

	Requirement Specifications
1.	The AI facial recognition software must be able to identify a user with 80% accuracy
2.	The AI facial recognition software must have an execution process between 3 to 7 seconds
3.	The FRL application will work with AI facial recognition and storage database to log user's facial ID
4.	The FRL application will notify users of attempted theft or breach of the system
5.	The FRL application will notify users of deliveries to the system
6.	The system will have a 6-digit code lock, in case of facial recognition failure.
7.	The power supply shall be capable of powering multiple sensors and accessories
8.	The FRL application database allows up to 20 GB of storage

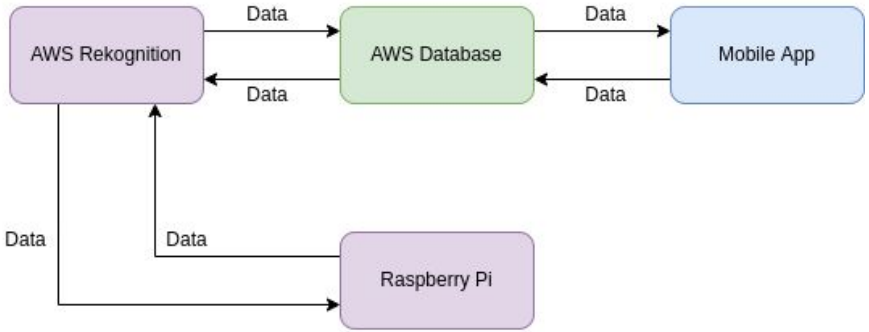
Project Constraints

	Project Specifications
1.	The system shall be no taller than 4.5ft
2.	The system shall be no wider than 3ft
3.	The system shall not weigh more than 100lbs
4.	The system shall maintain a maximum temperature of 140° F
5.	The system shall regulate average temperature of 73° F
6.	The facial recognition camera shall be no larger than 3 x 2 x 4.5 inches
7.	Requires outlet source for Power

Hardware Block Diagram



Software Block Diagram



Julian

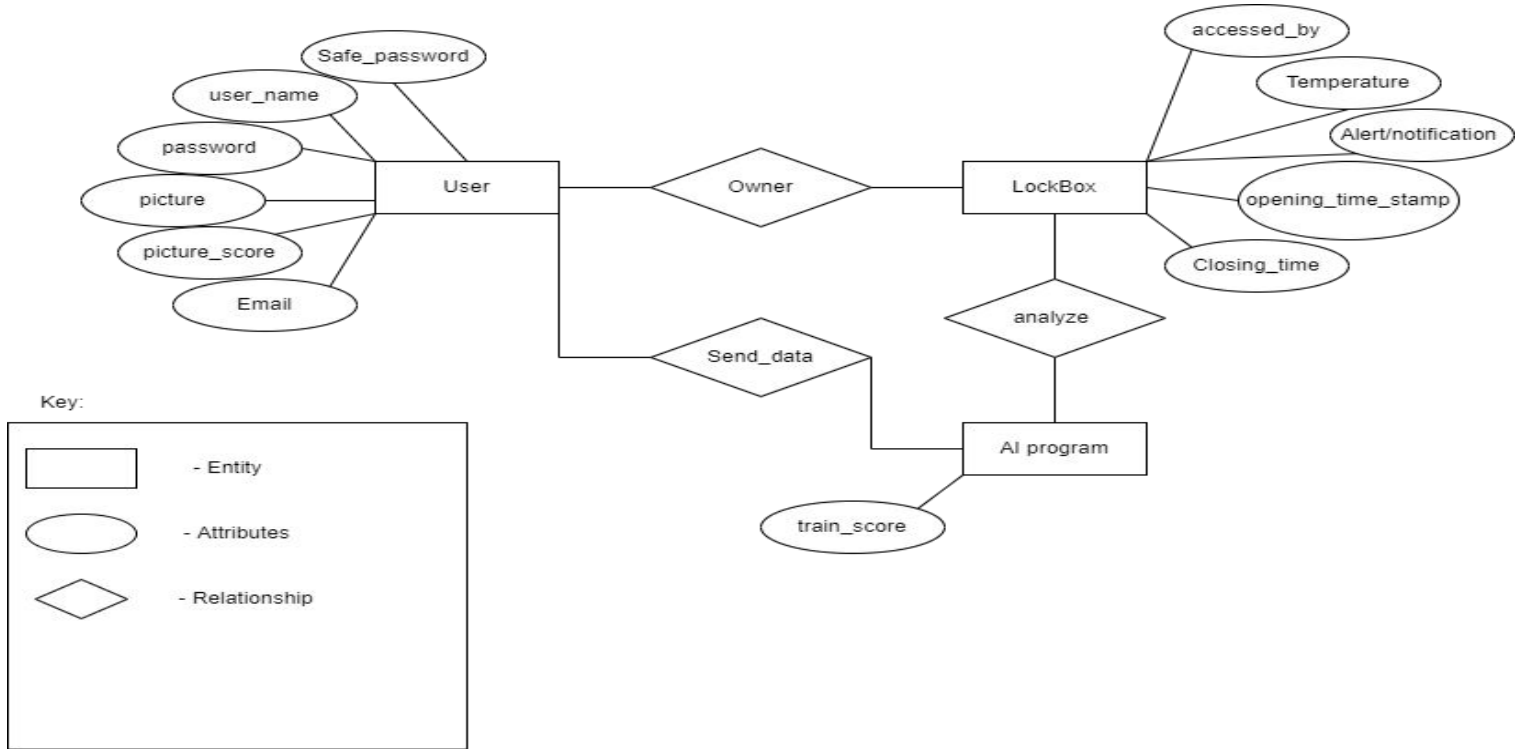
Che'

Ryan

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 has the ability to scale with the program, as user data increases

ER Diagram


Safe_password
user_name
password
picture
picture_score
Email
User
Owner
LockBox
accessed_by
Temperature
Alert/notification
opening_time_stamp
Closing_time
analyze
Send_data
AI program
train_score
Key:
- Entity
- Attributes
- Relationship

Database Structure

- Key-value type database.
- Three individual tables: User, Lockbox, AI.
- Both Lockbox and AI tables have dependency on User table
- Each user will have a unique username saved in the database, acting as the primary key.
- The primary key will give access to all other attributes to that specific user.

Facial Recognition Lockbox					
Primary Key	Attributes				
Username	Password	Email	Safe Code	Picture	Picture score
user1	Password	test@test.co	123456	file.png	1304
...	...	...	...	...	...
userN	Hi!	email@emai	654321	file.png	1255

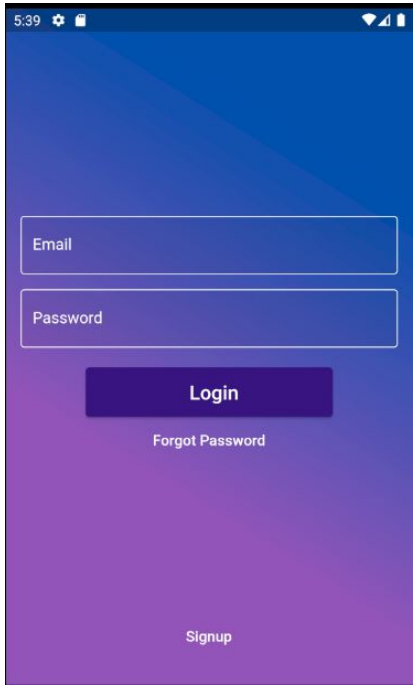
Database Security

- AWS will provide the main source of security.
- Providing a continuous monitoring system with threat detection, encryption, and key management.
- Failed attempt notification, allowing implementation of failsafe code.
- High-alert security at vital points across database, filtering incoming and outgoing traffic.
- Modifiable to fit our design of the Lockbox.

Database Optimization

- Proper Indexing, allowing for quick location and access to files.
- Only take in relative and necessary data.
- Good Programming

User Interface/Mobile App



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- Login page - takes in user email and password
- Forgot password allows user to reset their password
- Signup allows user to make a new account

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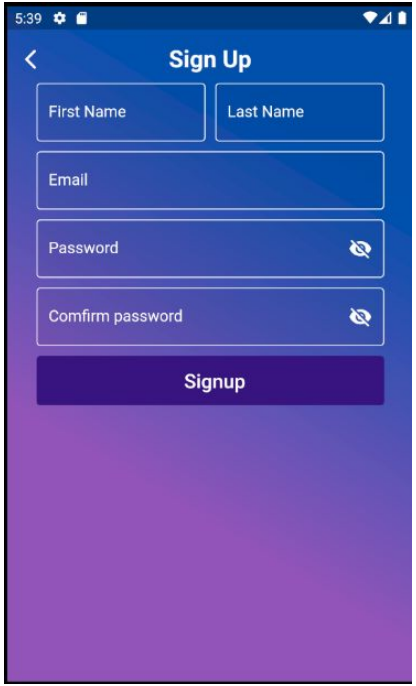
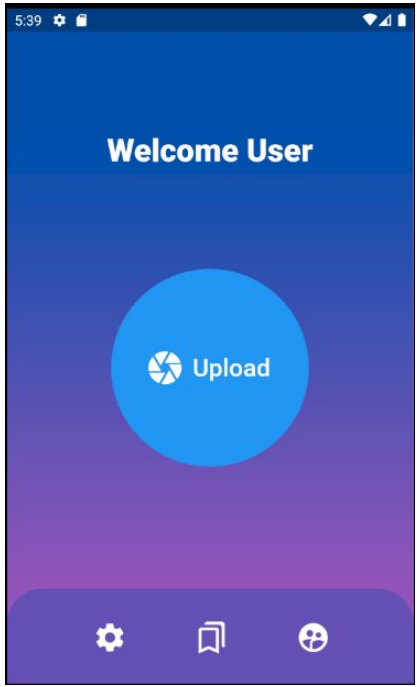
- Signup page - takes in a variety of user input fields
- Requires user to confirm password
- Requires password to meet certain specifications (has a number, capital and lowercase letter, a symbol, and is a length of 8 or above)



User Interface/Mobile App (cont.)



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- Home page for user
- Middle icon - Upload Page
- Bottom left - Settings Page
- Bottom middle - History Page
- Bottom Right - About Us Page

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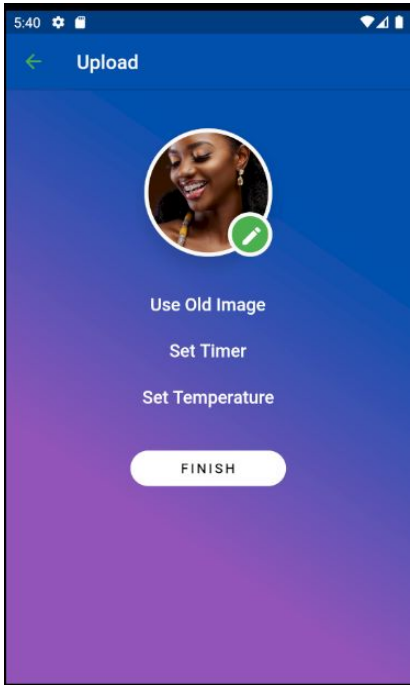
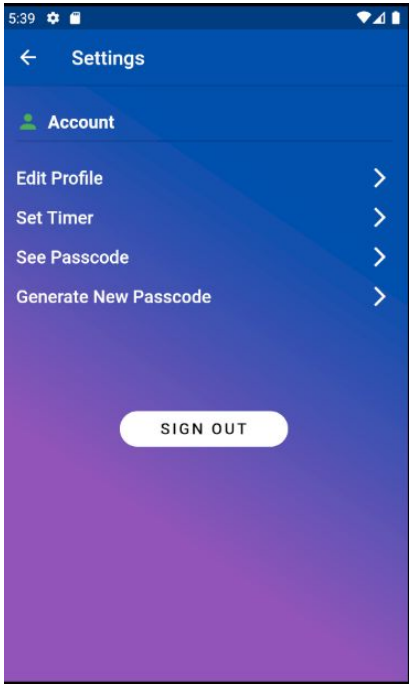
- The Upload Page
- Allows user to:
  - Upload a new image
  - Use an old image by accessing the History Page
  - Set timer for the Lockbox
  - Set temperature of Lockbox



User Interface/Mobile App (cont.)



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- Settings Page
- Allows user to:
  - Edit Profile
  - Set timer for their profile
  - See current passcode
  - Generate a new passcode

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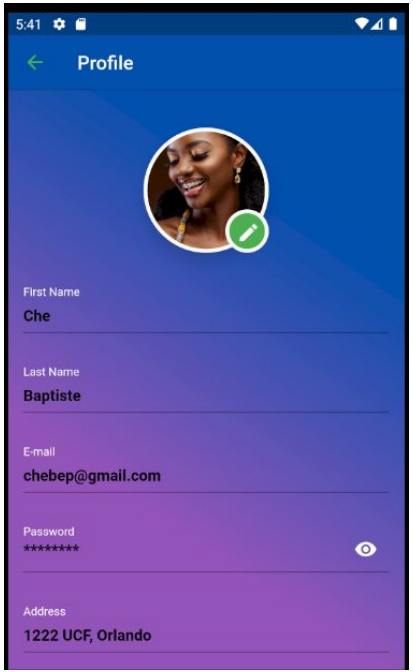
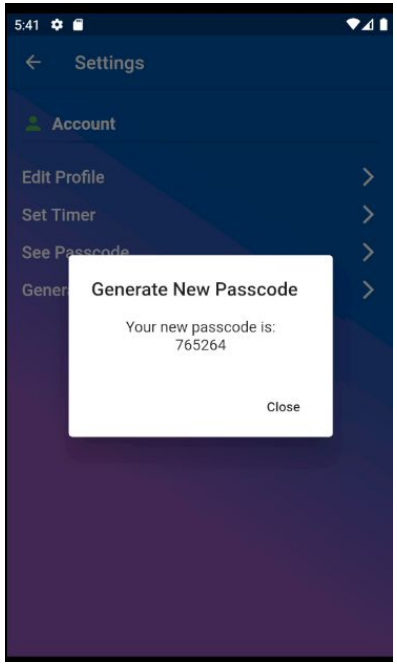
- The Profile Page
- Allows user to:
  - Change their first name
  - Change their last name
  - See their email (but cannot change it)
  - Change their password
  - Change their address



User Interface/Mobile App (cont.)



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- Generate new passcode
- A text box appears showing the user their new passcode
- Clicking the button again will generate a new passcode

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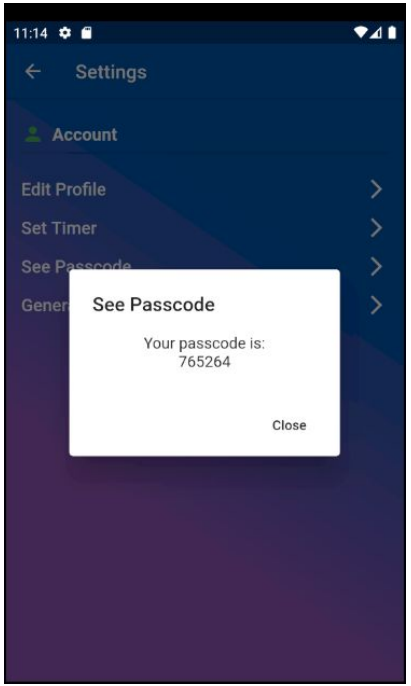
- See passcode
- Allows user to see current password
- Can click this one as much as you like, without changing your current passcode



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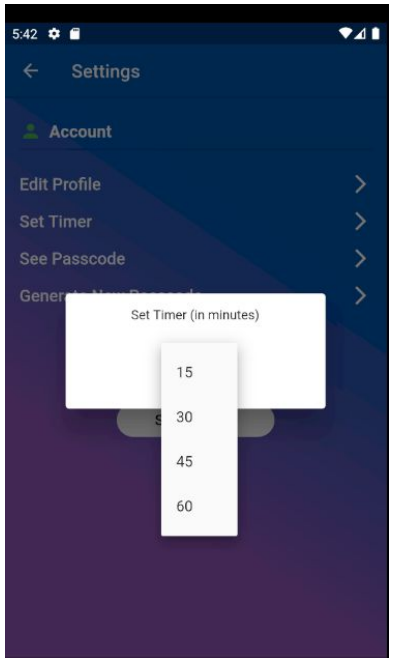

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- Set timer
- Allows user to change their default timer
- Timer is in minutes

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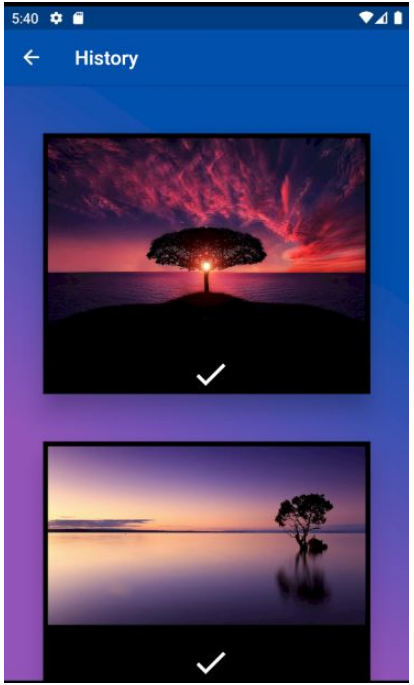
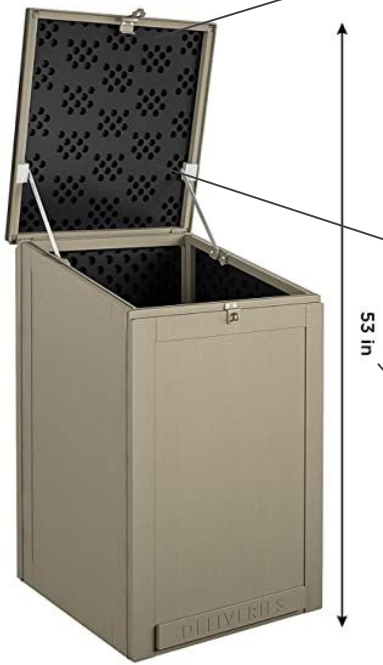
- History Page
- Allows user to see a list of images that they have previously used
- Clicking the image will take them to the upload page with the image loaded



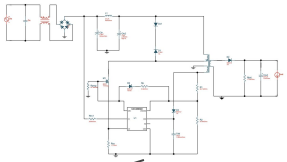
Hardware Design

Power connection for Raspberry Pi, heater, and solenoid

Heater placed at bottom to keep food warm



PCB to convert power for heater and solenoid switching

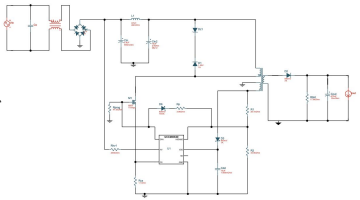


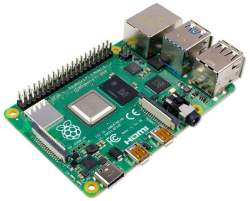
Raspberry Pi to communicate with Facial Recognition algorithm and activate lock and heater

Solenoid lock controlled by processor

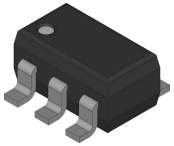
PCB Design Flowchart

AC/DC power conversion for solenoid (12 V at 0.54 A)





Raspberry Pi to handle AI application and communicate with MSP board



Switch to deliver DC power to solenoid

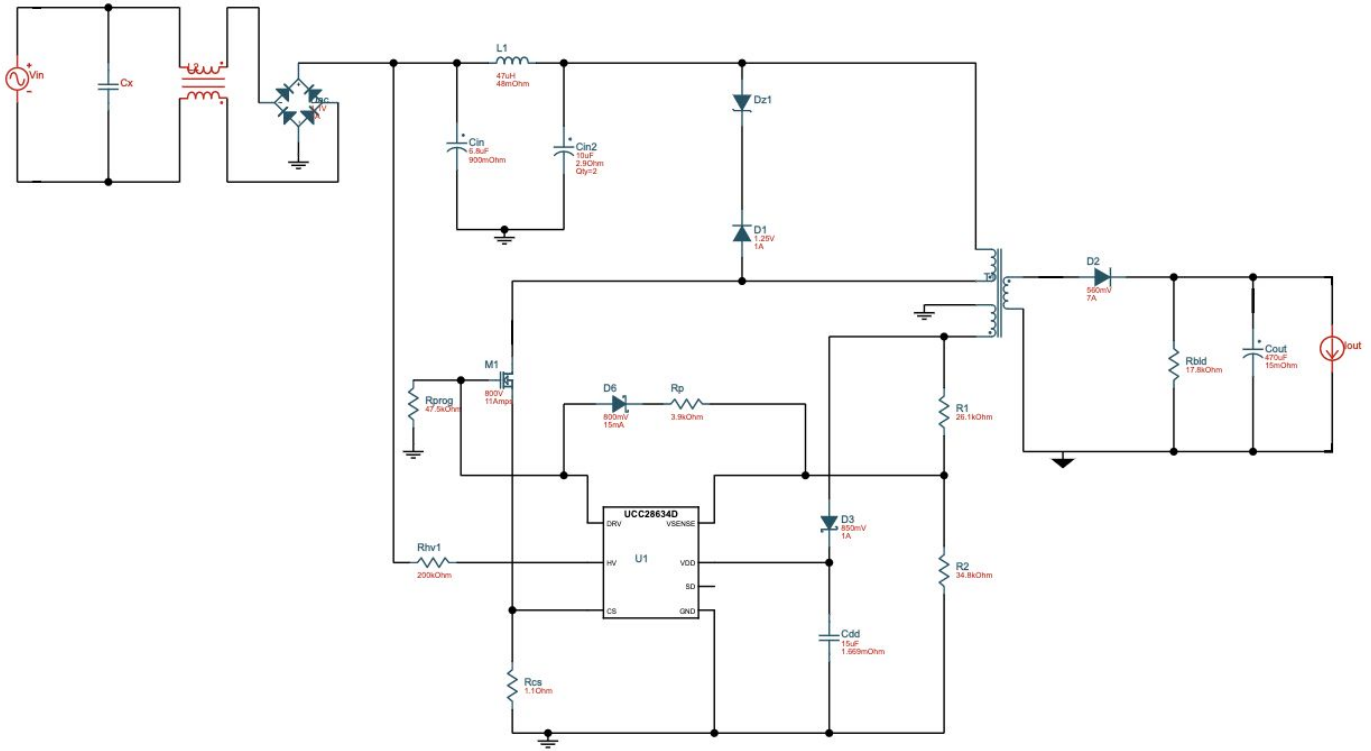
Solenoid lock controlled by processor

MSP430FR6989 to control hardware elements

Electrical relay to allow the MCU to switch on power to the heating element

Adjustable heating element

Power Conversion for Solenoid



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

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.

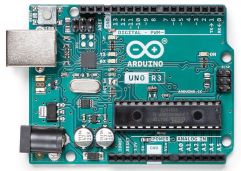
c.

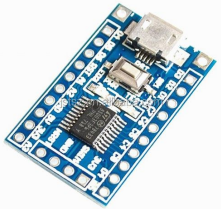
Why Raspberry pi?

- 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
- When used in similar projects: complete set-up time was roughly 3 hours
- Dependent on amount of training pictures, the pi took 3-4 seconds per picture
- Applicable with several different cameras, frame rate depending on quality of camera

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.
- 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 MSP board to unlock solenoid locking mechanism

Administrative Content

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
Heating Element	$40
Total	**~$160**

Relevant Standards

Food Heating

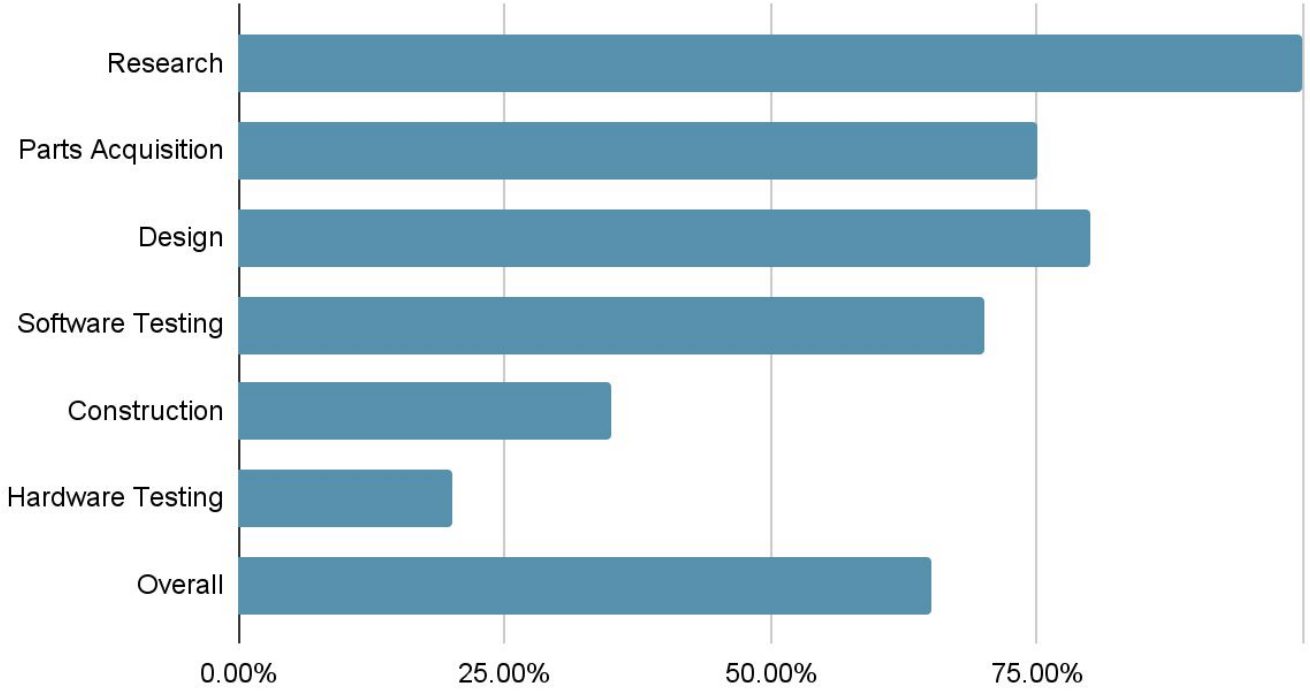
- The FDA recommends hot foods be held at 120-140° F
- Safe holding time at outdoor temperature is about one hour; for holding times longer than this, a heating element will be used
- An adjustable heating element will allow the user to set the desired warming temperature with a dial; the element pictured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

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

Progress by Category



Projected Semester Schedule

Currently End of **Week 3**

- **Weeks 4-7**: Design PCB & Assemble Prototype
- **Weeks 8-11**: Test Prototype & Fix Software Bugs
- **Week 12**: Finalize Documentation & Presentation
- **Week 13**: Prepare for Presentation
- **Week 14**: Final Presentation

Issues

- During testing, AWS suspended our account due to suspicious activity. Thought to happen because we were using an older version of the software
- During testing, we found that our version I board design, one of the resistor blow.
- In version II of our board, one of the tracing in the board short-circuited.
- 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.

Questions?