G-Lock Design Presentation

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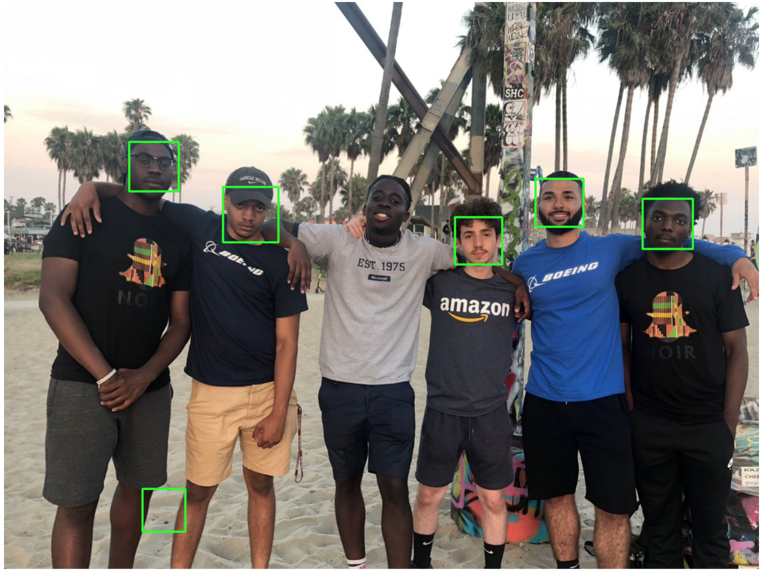
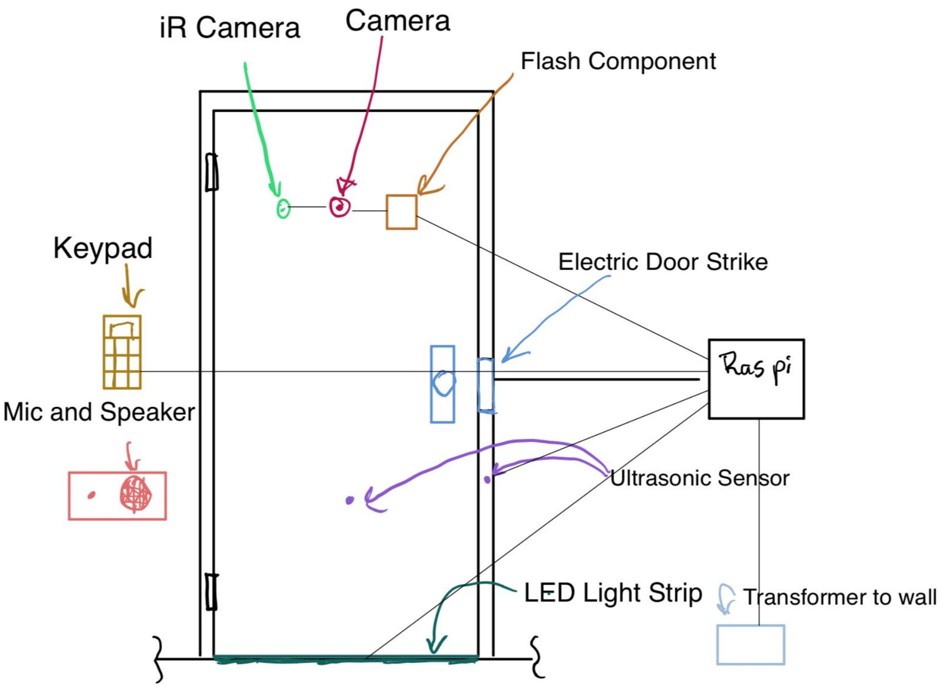
Problem



- 7 Roommates who live in the same house
- Difficult to manage key access throughout the day
- No easy way to communicate remotely with people at the door
- Need a secure, accurate, and seamless method for us to enter the house



- Faces as keys
- Give complete control to Homeowners
- Machine learning for Identification
- Circuit for unlocking/locking door
- Web Application interface

System Specification

- RasPi will serve as central processing hub (Python)
  - Handle Network Traffic between RasPi and WebApp clients (Flask)
  - Control Hardware through pins and usb connections
  - Run ML Test Suite which includes training with labeled images and testing with new images
  - Interact with Hardware through GPIO Pins and USB Ports
- Clients consists of devices connected to RasPi Server
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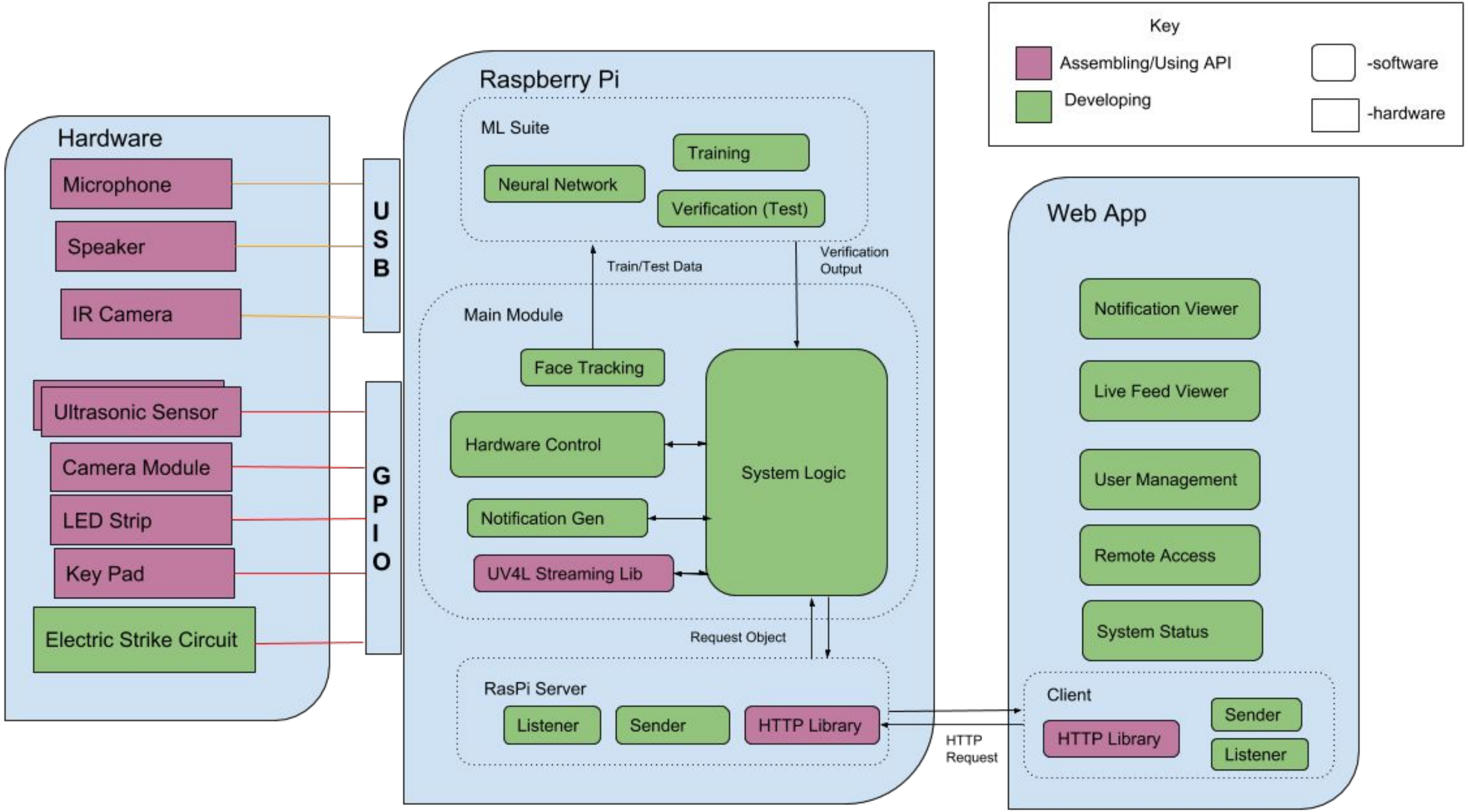
  - Interact with RasPi server through HTTP Requests (React Requests)
  - Notifications on system status are sent to client
  - User Management allows for user to add images to the training model
  - Send remote lock command to RasPi through POST Request
  - Stretch: Send voice input from app to system speaker for real-time conversation

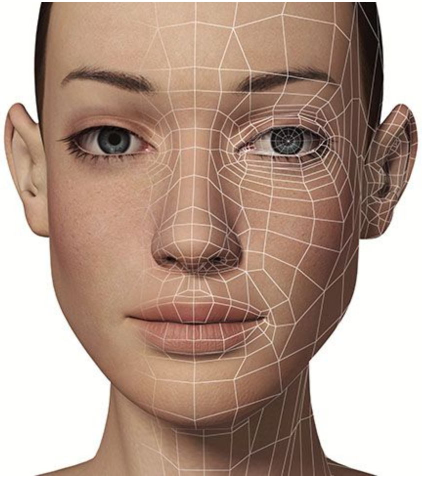
Block Diagram/Implementation Plan



Camera & Machine Learning

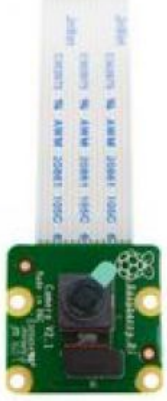
- Camera
  - Raspi Camera V2
  - Raspi IR Camera V2
- Facial Detection
  - OpenCV Library for Facial Detection
  - Use detection to capture screenshot of face
  - Converts Faces into an array of pixels which will be fed into CNN
- Machine Learning
  - Convolutional Neural Network to output feature vector
  - Feature vector used to determine if face matches resident
  - PCA for dimensionality reduction for verification speed up
  - Training images both pre-installed and added from webapp

- Stretch Goals
  - 2-camera 3D Profile
  - Regular Camera + IR Camera Superimpose



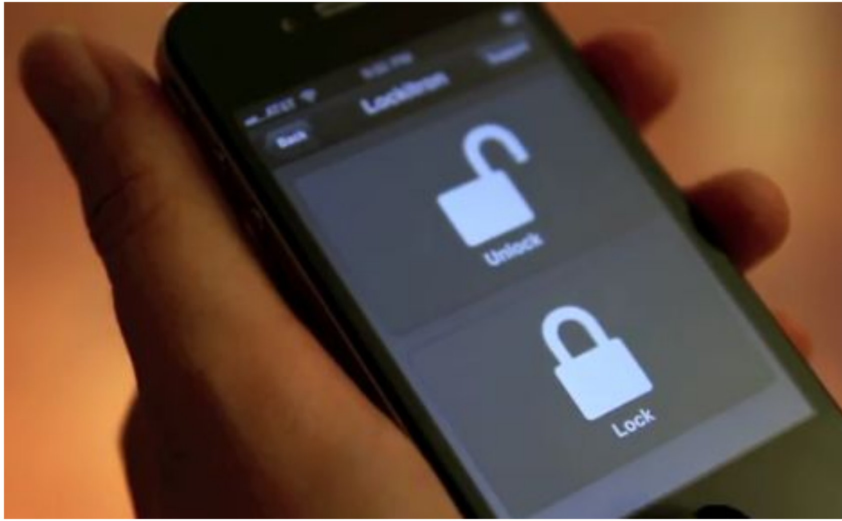
Hardware

- Circuit Components
  - 12V Fail Secure Electric Strike
  - 4x4 Numeric Keypad (9-pin)
  - Mini External USB Stereo Speaker
  - LED Lightstrip
  - 12V Power Adapter
  - 12V Power Bank
  - Mosfet, Diode
- Hardware
  - Raspberry Pi v3 Model B
- Sensors
  - Mini USB Microphone
  - IR Distance Sensor
  - Ultrasonic Sensor



Mobile Application

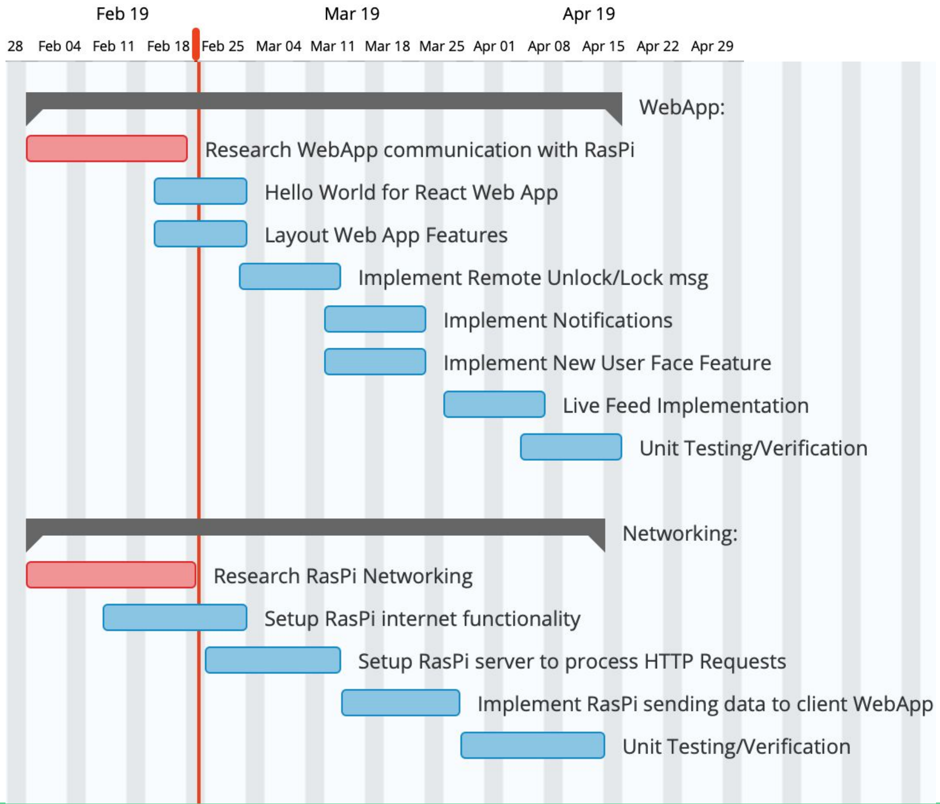
- React Native Mobile application
- Unlocking/Locking door through HTTP Requests
- Simple ‘Requests’ Package to send to RasPi server
- Voice messages to Raspberry Pi
- View Livestream of Camera
- Notifications and updates of system
    - Includes operation status
    - Log of system activity



Big Decisions

- Magnetic Lock / Electric Strike / Deadbolt and servo
  - Electric Strike makes unlocking simple / easy to integrate
  - Keypad interface serves as fail safe for entering house
- Pixy Camera vs Pi Camera vs iR camera
  - Can use many Pi/IR cameras together w/ multi camera mount
- Neural Network vs. EigenFaces vs. FisherFaces
  - Creating own algorithm allows for highest accuracy
- React Native Mobile App vs. Web Interface
  - React Native more deployable, better user experience
- Risk Factors
  - Slow Computation, Network Failures, Poor Lighting Conditions

Schedule



Feb 19
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Apr 19
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Feb 04
Feb 11
Feb 18
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Mar 04
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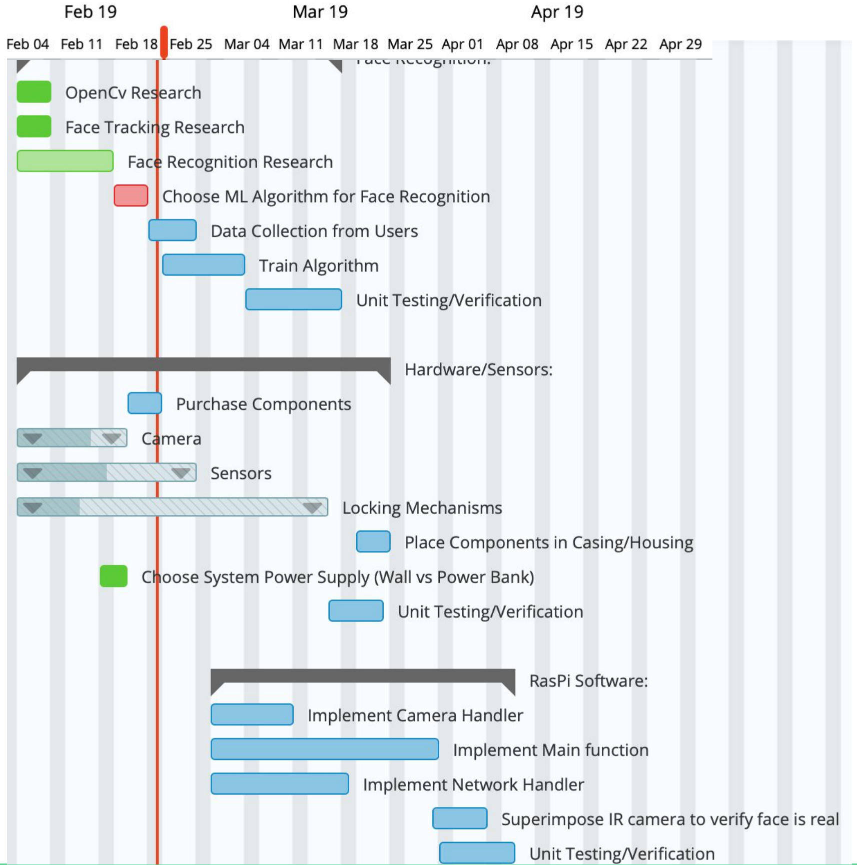
Mar 25
Apr 01
Apr 08
Apr 15
Apr 22
Apr 29
WebApp:
Research WebApp communication with RasPi
Hello World for React Web App
Layout Web App Features
Implement Remote Unlock/Lock msg
Implement Notifications
Implement New User Face Feature
Live Feed Implementation
Unit Testing/Verification
Networking:
Research RasPi Networking
Setup RasPi internet functionality
Setup RasPi server to process HTTP Requests
Implement RasPi sending data to client WebApp
Unit Testing/Verification



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Face Recognition:
OpenCv Research
Face Tracking Research
Face Recognition Research
Choose ML Algorithm for Face Recognition
Data Collection from Users
Train Algorithm
Unit Testing/Verification
Hardware/Sensors:
Purchase Components
Camera
Sensors
Locking Mechanisms
Place Components in Casing/Housing
Choose System Power Supply (Wall vs Power Bank)
Unit Testing/Verification
RasPi Software:
Implement Camera Handler
Implement Main function
Implement Network Handler
Superimpose IR camera to verify face is real
Unit Testing/Verification

Work Distribution

Omar

- Feature Detection
- Neural Network Development
- Facial Recognition
- Image Profile Creation

Chinedu

- Raspberry Pi System Logic
- Circuit Creation
- Hardware Control
- Live Streaming

Joel

- React Native application
- Networking on Raspi Server and WebApp Client
- Data Exchange Setup

Testing, Metrics, and Validation

Feature	Metric	Goal
App Synchronization	Lock event latency	10 sec.
User Experience	Unlock Time	Door unlocked in 5 sec
Face Detection	Successful Detection Rate	Day: 90% Night: 85%
Face Verification	Verification Computation	1-2 FPS
Electric Strike Unlock	Unlock Time	1.0 sec.
New Face Addition	Face Registration Time	2 min.