

Midway Design Review: Automated Mail Sorter

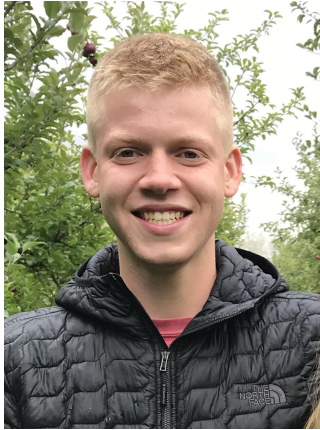
Team 14

Dan Emerson, James Finn,
Harrison Liu, Long Nguyen

Advisor: Professor Holcomb



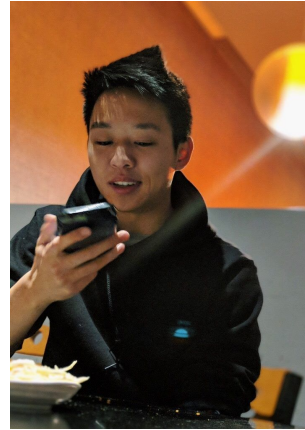
Team 14



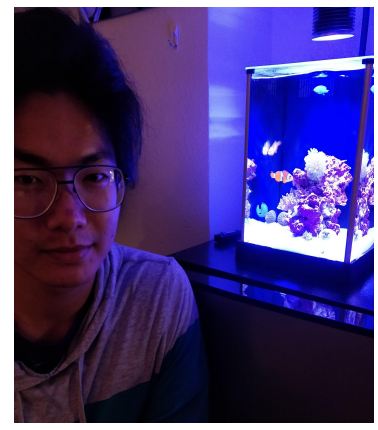
Dan Emerson
ME



James Finn
CSE



Harrison Liu
CSE



Long Nguyen
CSE

Problem Statement

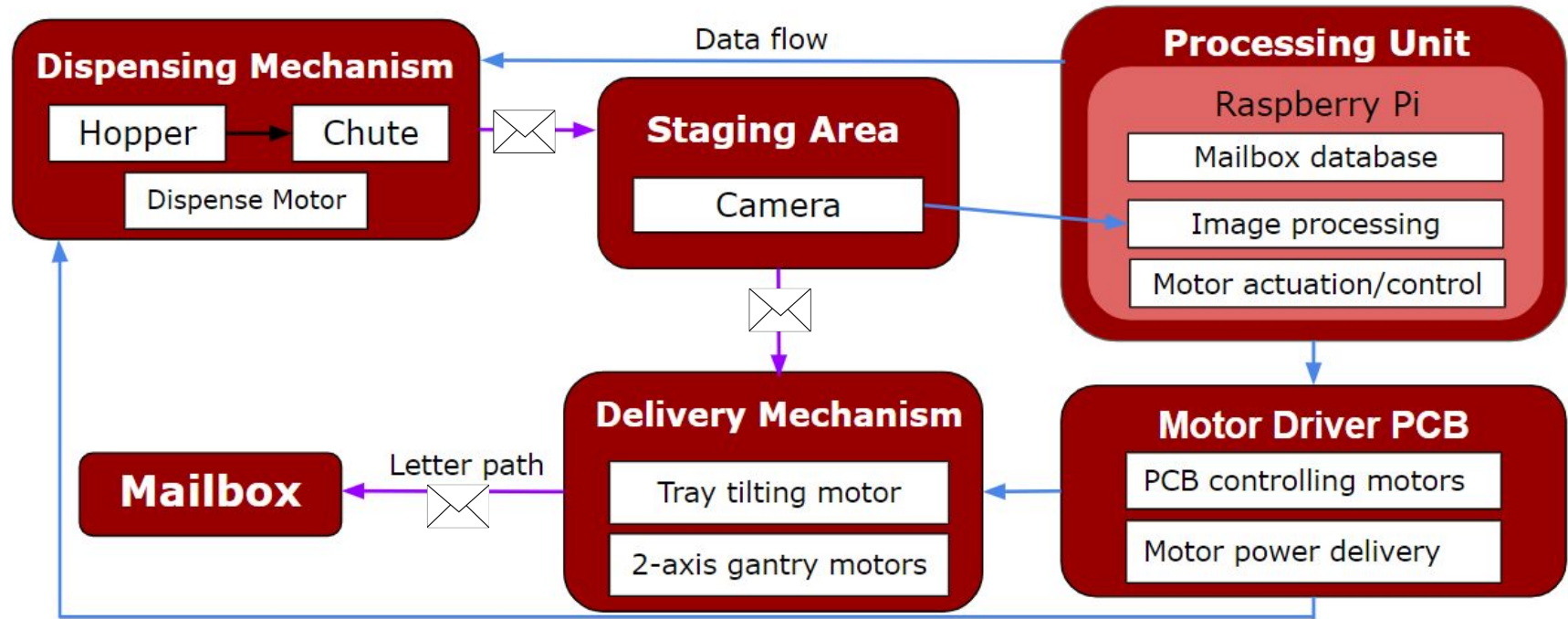
Sorting mail is a mundane and routine task that can be significantly enhanced through automation. Automation would improve the cost efficiency compared to a traditional mail carrier.

Currently there are no automated last-mile delivery implementations available on the market. We plan to fulfill this gap by designing a small scale automatic mail sorter for individual office mailbox arrays.

System Specifications

1. Support standard envelope size of 4½ in x 9½ in
2. Hopper dispenses exactly 1 letter to be processed with 95% accuracy (75% MDR)
3. Identify correct letter destination by reading with 99% accuracy (QR/typed/handwritten) (90% MDR)
4. Deliver letter into correct mailbox by tilting mechanism with 95% accuracy (no req. for MDR)
5. Capable of sorting 1,000 letters per day (no req. for MDR)

Block Diagram



MDR Deliverables

1. Dispense one letter at a time into staging area
2. Identify letter destination by reading barcodes
3. Transport letter to destination along one axis, with a design that can be scaled to two axis

Dispense Mechanism

- Servo motor attached to wheel pulls out one letter from bottom of hopper
- Adjustable gate keeps multiple letters from sliding out
- Letter slides down chute, landing in staging area

Image Processing

- Using a Raspberry Pi camera v2, takes picture of envelope with the picamera and time libraries
- Pyzbar and OpenCV are used to process the image, locate the barcode, and translate that into a name/address
- First, image is transformed from RGB to grayscale
- Locate barcode through cluster of black/white lines
- Function 'decode' is used to decipher barcode into understandable name/address

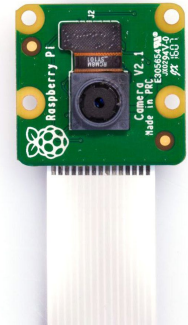


Image Processing (Testing)

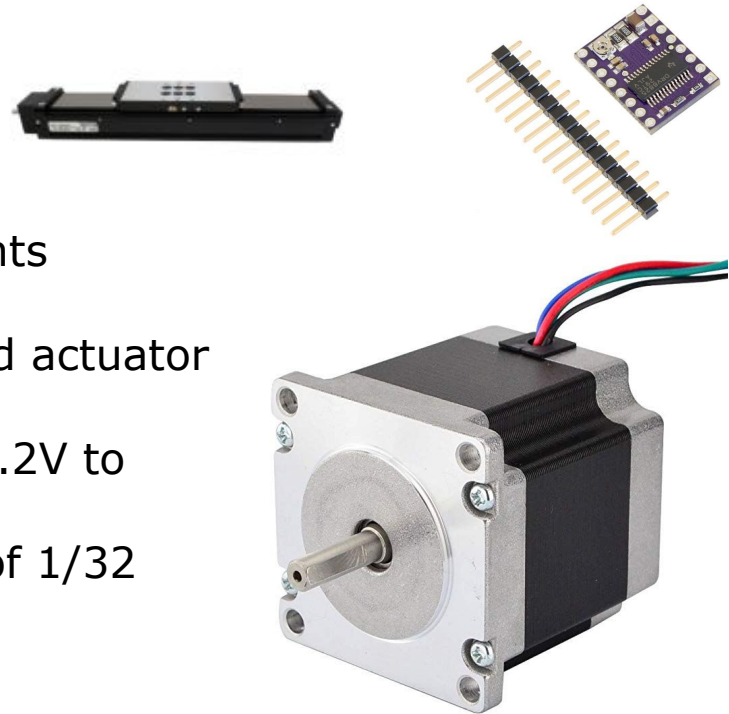
Tested to accurately read names 94% of the time

- Oriented barcodes at varying angles
- 28/30 successful reads during tests

Read errors occur in poor lighting and when camera lens focus is not adjusted accordingly

Delivery Mechanism

- Bosch R146520000 Linear Actuator
 - 300mm of linear travel
 - Precise ball screw drive
- NEMA23 Stepper Motor
 - Capable of discrete 1.8° movements
- Flexible 6.35mm to 5mm coupling
 - Relieves stress between motor and actuator
- Pololu DRV-8825 stepper motor driver
 - Powers stepper motors between 8.2V to 45V up to 2.2A
 - Capable of microstep resolutions of 1/32 step



Delivery Mechanism (Testing)

Tested to work and accurately move the delivery tray to the appropriate mailbox with $\sim 5\%$ positional error

Errors occur when actuator travels a long distance and ball screw/linear guides inside the actuator catch/skid.

Software

- camera.py: captures image of envelope using Raspberry Pi camera
- barcode.py: locates and processes barcode images and stores name/address for delivery
- servoMotor.py: controls motor for dispense mechanism
- verticalMotor.py: controls motor to move delivery tray given specified direction and distance

Software

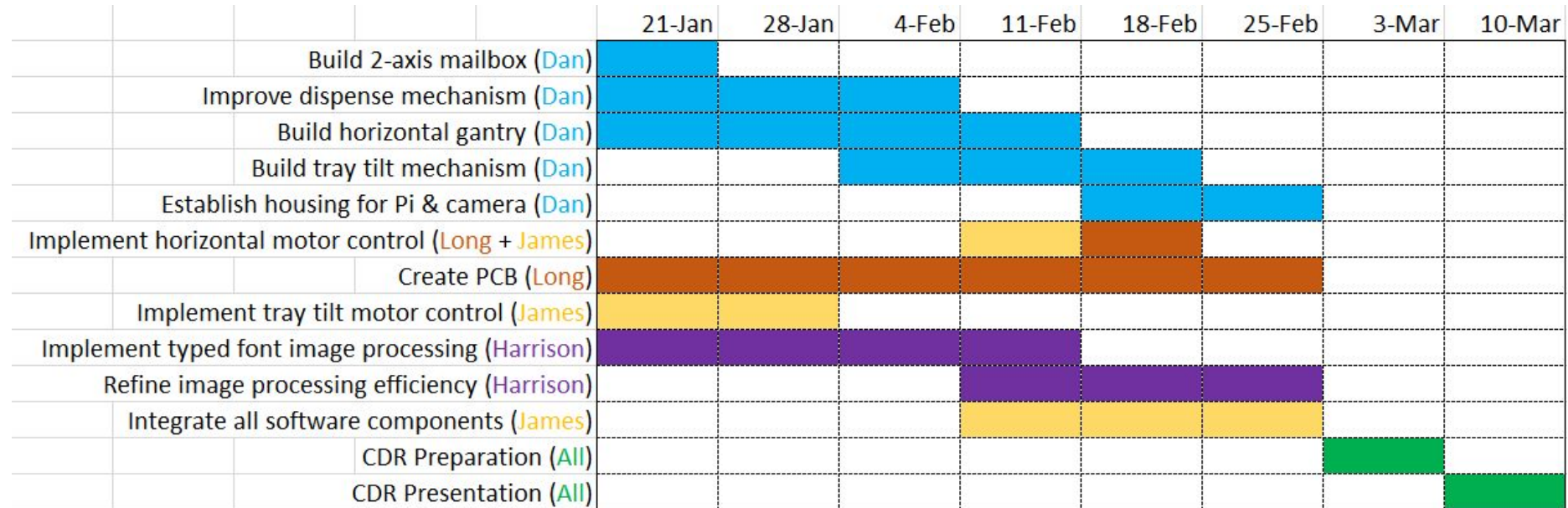
main.py:

- Runs in virtual environment to support opencv
- While loop
- First calls servoMotor.py
- Next calls camera.py and barcode.py to receive delivery address
- Finally calls verticalMotor.py using address parameters to move tray to destination and back to origin




Proposed CDR Deliverables

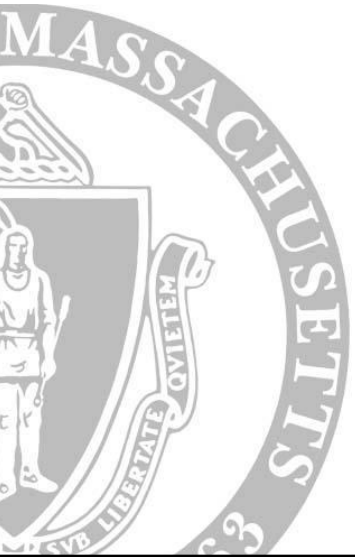
1. Identify correct letter destination by reading typed fonts
2. Deliver letters to mailboxes across 2-axes
3. Establish and fabricate housing location for Raspberry Pi and camera
4. Implement motor driving circuit on PCB
5. Implement tray tilting mechanism that deposits letter into box

Gantt Chart



MDR Deliverables

1.  Dispense one letter at a time into staging area
2.  Identify letter destination by reading barcodes
3.  Transport letter to destination along one axis, with a design that can be scaled to two axis



Demo

MDR Demo Video



Questions?

