

Automated Mail Sorter

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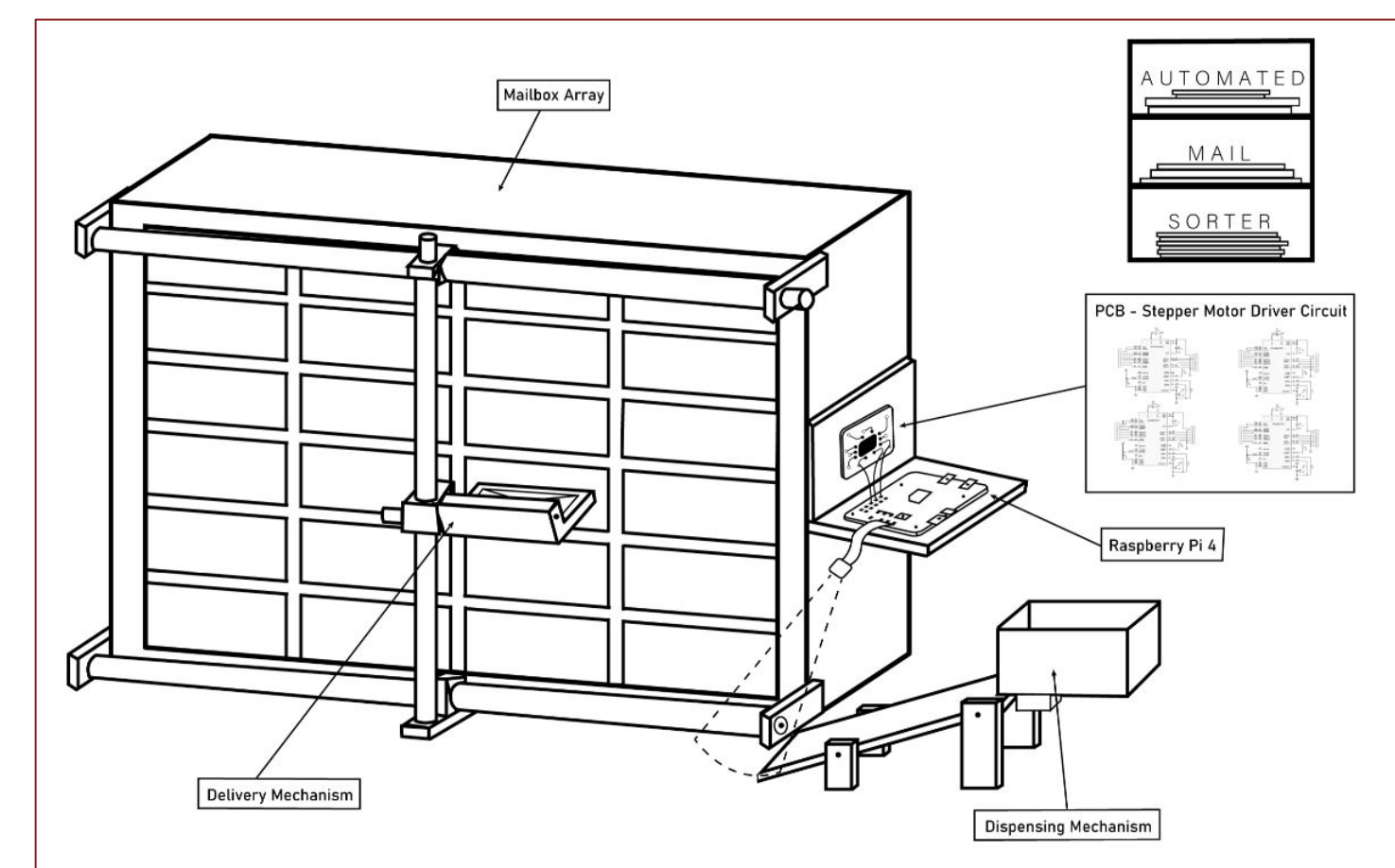
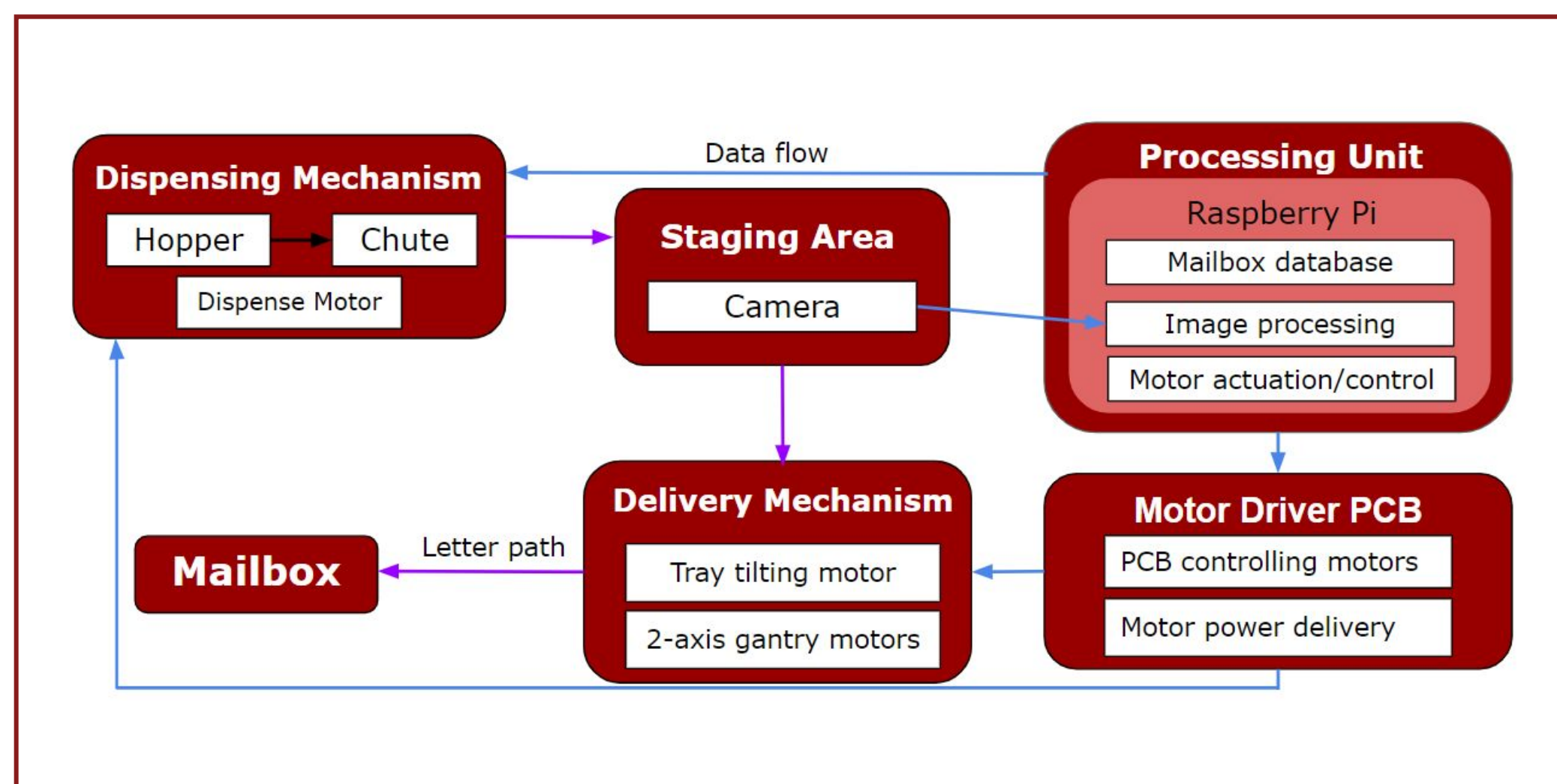
Abstract

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 planned to fulfill this gap by designing a small scale automatic mail sorter for individual office mailbox arrays. Our design features a hopper system that dispenses one 4 1/8" x 9 1/2" envelope at a time into a delivery tray. From there, a photo is taken of the envelope, and text image processing is applied on the photo to determine the address of the recipient. The delivery tray then moves the envelope to the corresponding mailbox height and a tilting delivery mechanism is implemented to slide the mail into the correct slot. Finally, the delivery tray returns to its original position. This process repeats until the hopper is empty.

System Overview

We divided the system into three main subsystems. First we have the dispense mechanism, which is used to dispense exactly one letter from a hopper into the staging area. The dispense mechanism utilizes one servo motor (4.8V, 60rpm, 69.4oz-in) in an open loop subsystem. Second is the processing unit, which completes all text image processing on the envelope in the staging area using a Raspberry Pi, OpenCV functions and PyTesseract functions. Third is the delivery mechanism, which is the subsystem responsible for moving the letter from the staging area to the appropriate mailbox. The delivery mechanism consists of a 2-axis gantry and a delivery tray. The 2-axis gantry is powered by three stepper motors (NEMA 17, 1.4ohm, 2A, 84oz-in) driving three lead screws. The delivery tray is similar in design to the dispense mechanism, in the sense that it is powered by a servo motor which pushes the letters into the mailbox with a wheel.

Block Diagram



Results

In its state at CDR, our project was able to dispense letters onto the staging area, read typed text addresses on the letter, and direct the letter to the appropriate mailbox by turning the appropriate gantry motors. Two of the three gantry lead screw rails were in place to fully support one axis of motion on the 2-D gantry. A third lead screw rail was needed to fully support both axes of the 2-D gantry. Additionally, a delivery tray design needed to be fabricated. Our final design choice was similar to the dispense mechanism, with a closed loop subsystem centered around a servo motor to push the letters into the mailbox.

Specifications

Requirement	Specification	Value
Size	Support delivery of standard envelope size	4 1/8 in x 9 1/2 in
Image processing	Accuracy in recognizing typed font	≥ 99%
Speed	Letters processed per day	≥ 1000
Dispensing	Accuracy in dispensing exactly 1 letter	≥ 95%
Delivery	Accuracy in delivering a letter to the correct mailbox	≥ 95%

Acknowledgement

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