TEXAS A&M UNIVERSITY
Engineering

Booth Number: VB24

Talaria Mail Delivery Robot

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Problem Definition

Frequent trips to the mailroom can become both tedious and time-consuming. As office mailrooms become overcrowded with mail, the risk of smaller packages and files being overlooked increases.

Talaria's solution is a lightweight, autonomous robot designed to deliver mail in a typical office setting.

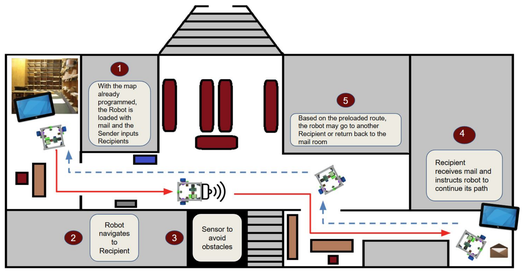

Figure 1. Conceptual Block Diagram

Methodology

The components listed below were used in the assembly of this robot, with the SCUTTLE robot serving as the inspiration.

ELECTRICAL

- USB-PD 65W Power Bank
- Two Raspberry Pi 4 Model B units (2GB/4GB)
- ELECROW 7 inch capacitive touchscreen
- RPLIDAR A1M8 (360°, 12 meter LIDAR)
- HW-231 Motor Driver
- Motors (200 RPM, 12V)
- Two AMS5048B Encoders

MECHANICAL

- 3030 T-Slot Aluminum
- PLA Filament
- Cast Acrylic Sheets
  - ¼" acrylic is used in load-bearing areas
  - ⅛" acrylic is used for all other applications

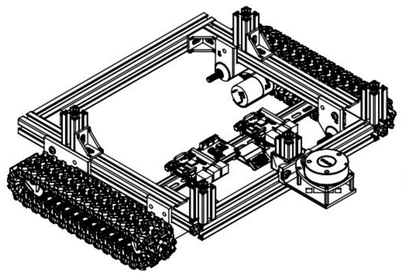

Figure 2. Chassis Base Frame

Engineering Analysis

MECHANICAL

The motor driver, encoder I^2C bus, and both Raspberry Pis are mounted on a steel DIN rail with the battery secured to a second rail as seen in Figure 2. This setup securely mounts all electrical components while maintaining easy removal of components for maintenance and modifications.

SCUTTLE wheel mounts were re-engineered to integrate with tank track systems. The mail storage solution employs a commercial off-the-shelf (COTS) file organizer while the package base serves as the primary load-bearing component. Refer to Figure 3 for additional details.

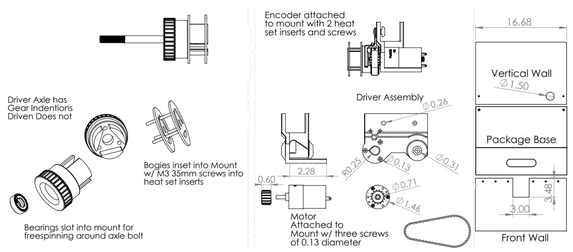

Figure 3. Mechanical Design Details

SOFTWARE

The system is split into two halves: the Navigator and Control Panel. The Navigator execute navigation commands and includes a Raspberry Pi, motor driver, LIDAR, and encoders. The Control Panel has a touchscreen and its own Raspberry Pi to provide a friendly user interface for planning and accepting deliveries. See Figure 4 for additional details.

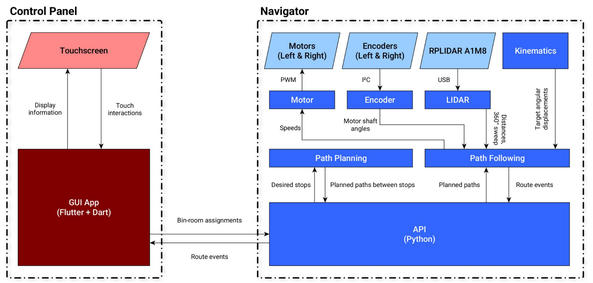

Figure 4. Software Modules

PATH PLANNING

Path planning consists of three steps. First, the shortest route is determined by solving the Travelling Salesman Problem using Dijkstra's algorithm. Next, the path is discretized by evaluating key points along the route and merging them into linear segments. Finally, reverse odometry is used to calculate the target angular displacement for each wheel. The default floor map is Fermier Hall, whose path is visualized in Figure 5 as generated by a custom tool.

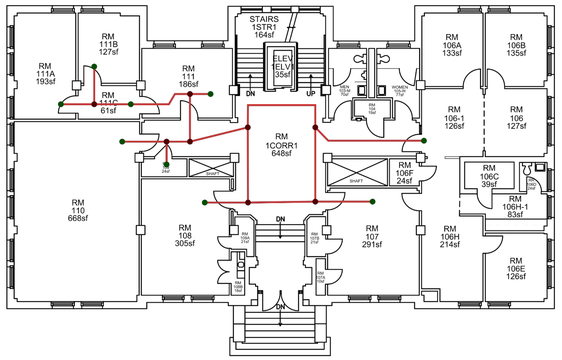

Figure 5. Programmed Fermier Hall Floormap

PATH FOLLOWING

The robot begins movement with an 80% duty cycle, using encoder readings to compute $\Delta\theta$ and accumulate displacement. If the sign of (θ_{target} - $\theta_{current}$) changes between iterations, the Intermediate Value Theorem indicates the target has been reached, and the motors are stopped. The metrics involved in this process are shown in Figure 6.

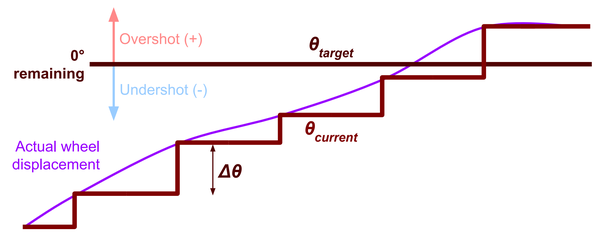

Figure 6. Tracking Angular Displacement

USER INTERFACE

The Control Panel includes four screens: Home (startup), Route Planning (assign rooms to bins), Route Confirmation (verify assignments), and Status (delivery states such as 'In Transit', 'Arrived at Stop', and 'Return Home').

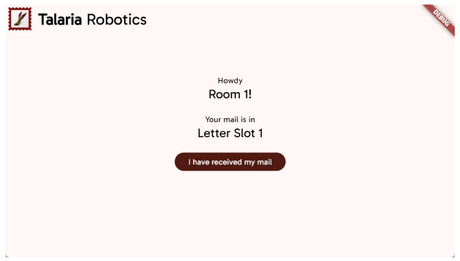

Figure 7. Arrived At Stop Screen

Outcomes

The robot is capable of operating under a full load of at least 15 lbs in Fermier Hall and successfully navigating to selected rooms. Comprehensive documentation can be accessed by scanning the QR codes below.

Test Plan

Software Documentation

References

1. SCUTTLE robot – Project Founder: David Malawey

Acknowledgements

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