



Carleton Mail Delivery Robot

Group 89

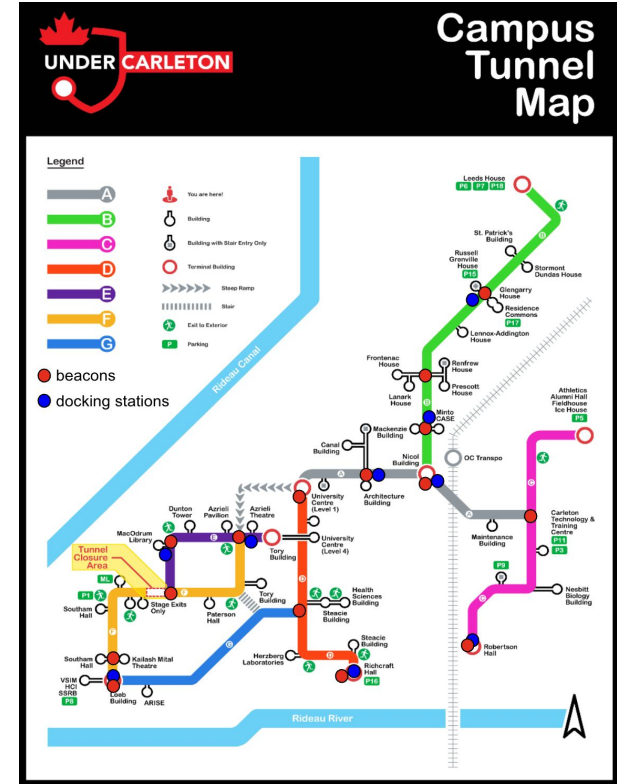
Supervisor: Dr. Babak Esfandiari

Max Curkovic
Cassidy Pacada
Bardia Parmoun
Matt Reid

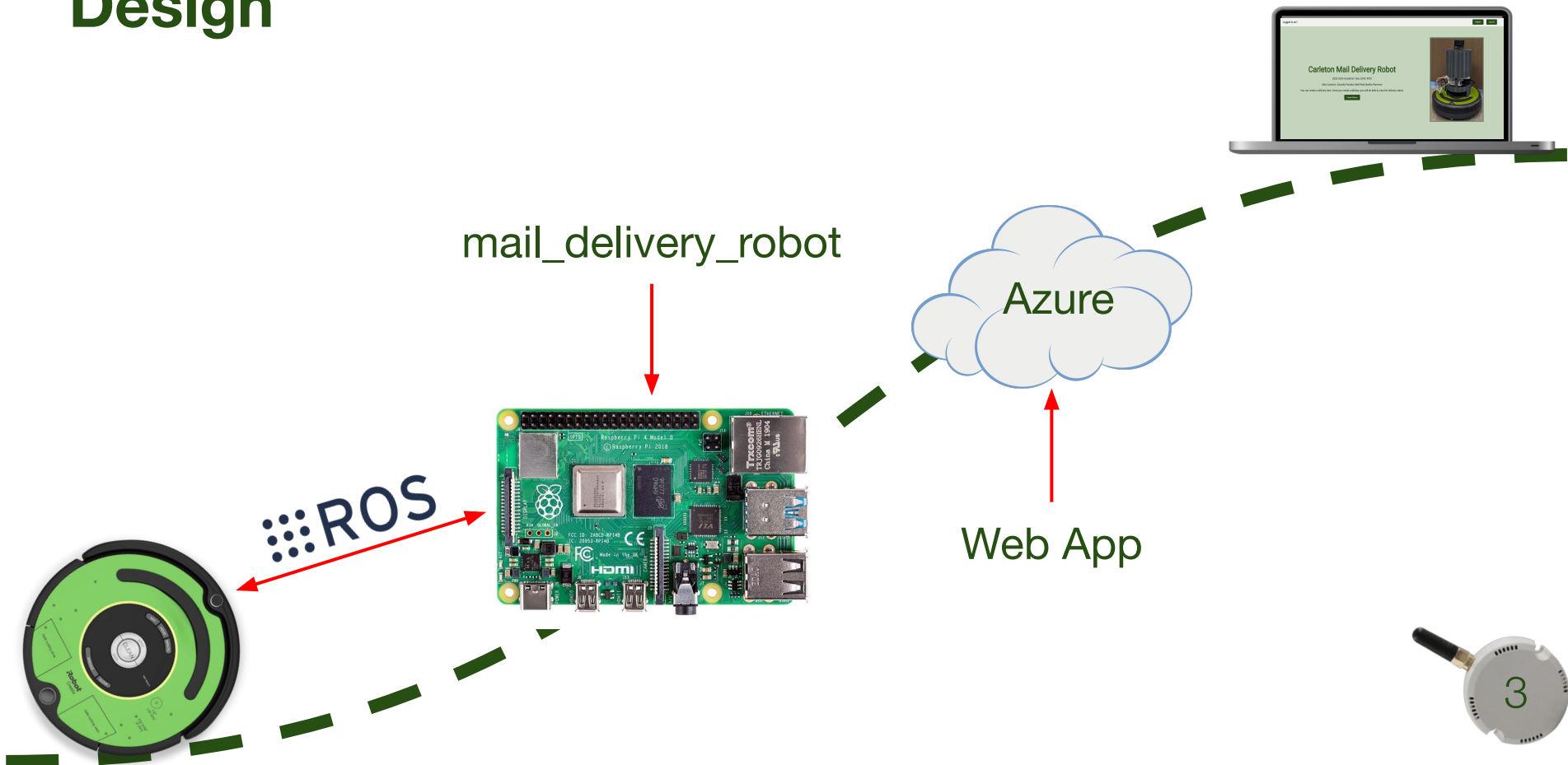


Introduction

- What?
 - Improve the mail delivery in the tunnels
- Why?
 - Faculty gets mail delivered everyday
- How?
 - Using programmable roombas
- Goals?
 - Cost-effective and resilient



Design



Hardware Implementation



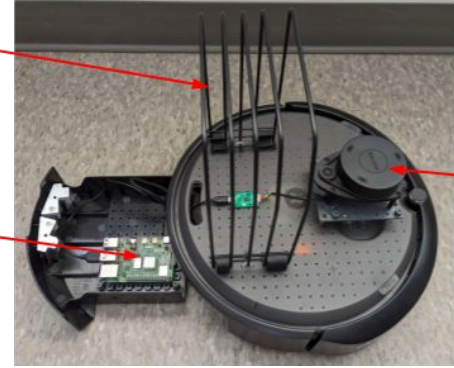
LiDAR Sensor

Mailbox

Battery Bank

Raspberry Pi 4

iRobot CREATE 2



Mailbox

Raspberry Pi 4

LiDAR Sensor

iRobot CREATE 3



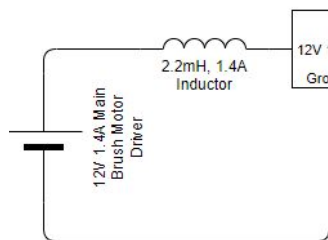
Dock Station



Bluetooth Beacon

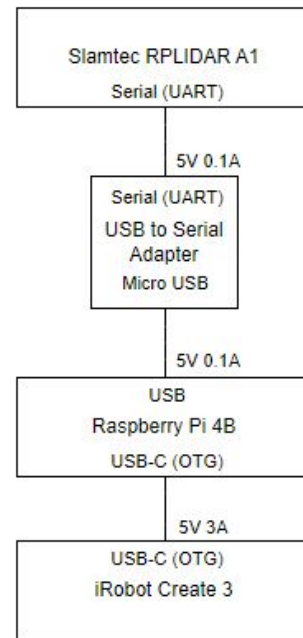
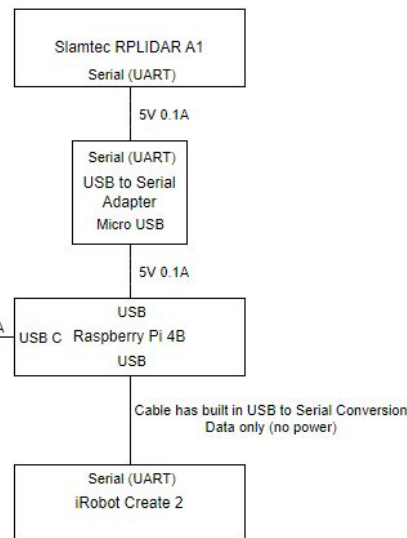


Hardware Design



Note: Main Brush Motor Driver power is output from iRobot Create 2

CREATE 2



CREATE 3



Software Implementation

- **Robot Backend**
 - A complete real time system
 - A detailed state machine for resiliency
 - Uses ROS as the middleware
 - Mainly developed in Python
- **Web Application**
 - A simple Spring Boot application
 - Mainly developed in Java
- **Simulator**
 - Simulates all the sensor data
 - Reduces the need for hardware testing

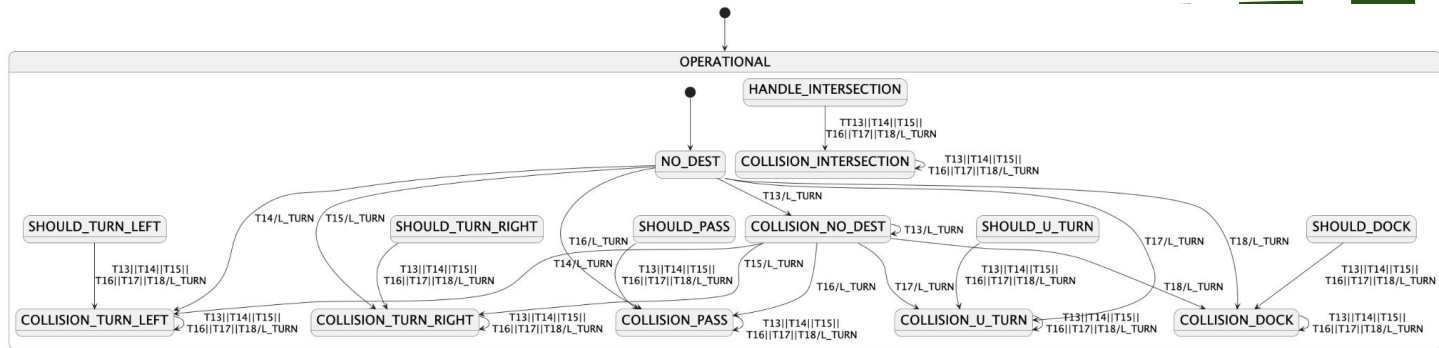
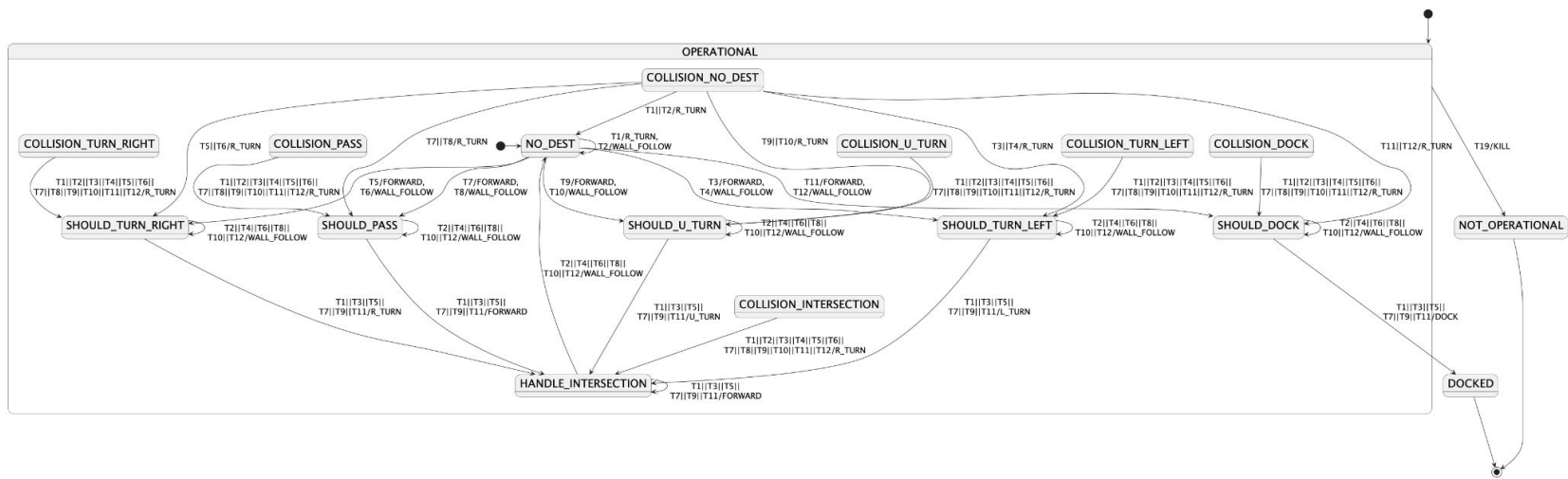


State machine

TRANSITION	ERROR	BUMPER	BEACON	LiDAR
1	FALSE	FALSE	NONE	FALSE
2	FALSE	FALSE	NONE	TRUE
3	FALSE	FALSE	LEFT	FALSE
4	FALSE	FALSE	LEFT	TRUE
5	FALSE	FALSE	RIGHT	FALSE
6	FALSE	FALSE	RIGHT	TRUE
7	FALSE	FALSE	PASS	FALSE
8	FALSE	FALSE	PASS	TRUE
9	FALSE	FALSE	U-TURN	FALSE
10	FALSE	FALSE	U-TURN	TRUE
11	FALSE	FALSE	DOCK	FALSE
12	FALSE	FALSE	DOCK	TRUE
13	FALSE	TRUE	NONE	x
14	FALSE	TRUE	LEFT	x
15	FALSE	TRUE	RIGHT	x
16	FALSE	TRUE	PASS	x
17	FALSE	TRUE	U-TURN	x
18	FALSE	TRUE	DOCK	x
19	TRUE	x	x	x

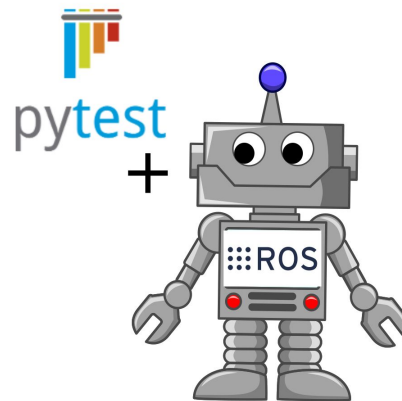


State machine



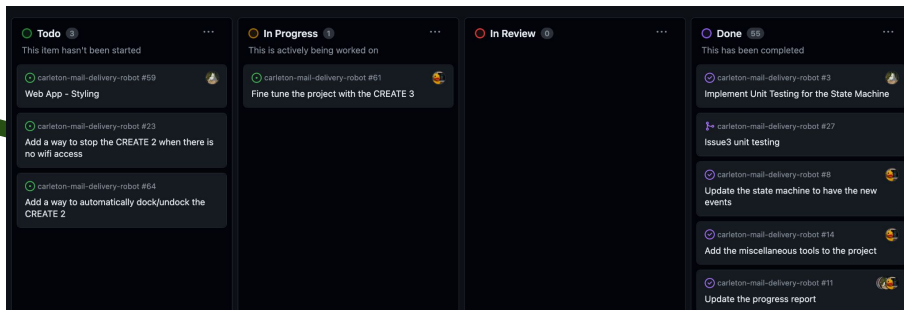
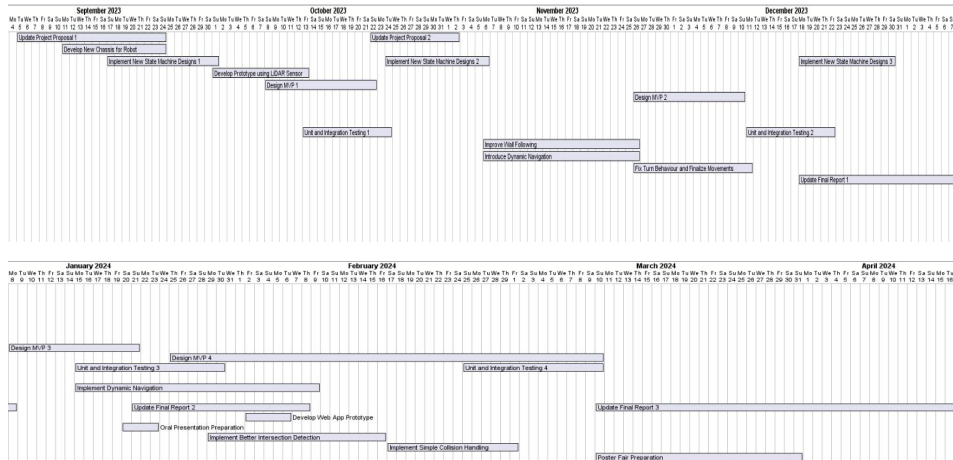
Testing

- Robot Testing:
 - Unit testing: Each individual unit
 - Integration testing: How units interact
- Web Application Testing:
 - Models and controllers
- Github Workflows:
 - ROS, Maven, Azure Deployment



Project Management

- GitHub issue tracking
- Agile development
- Code reviews
- Weekly meetings



Achievements

- Codebase works with CREATE 2 and CREATE 3
- Dependable hardware
- Strong wall-following
- Reliable left and right turns, U-Turns
- Effective collision handling
- Resilient navigation using a map
- Simple but efficient web application
- Steady testing framework



Contributions

- Max Curkovic:
 - Robot's navigation, web application
- Cassidy Pacada:
 - Robot's testing framework, web application
- Bardia Parmoun:
 - Robot's logic and control system
- Matt Reid:
 - Robot's hardware-related tasks

