PARROT

Parallel **A**synchronous **R**obots,
Robustly **O**rganizing **T**rucks

Project Proposal

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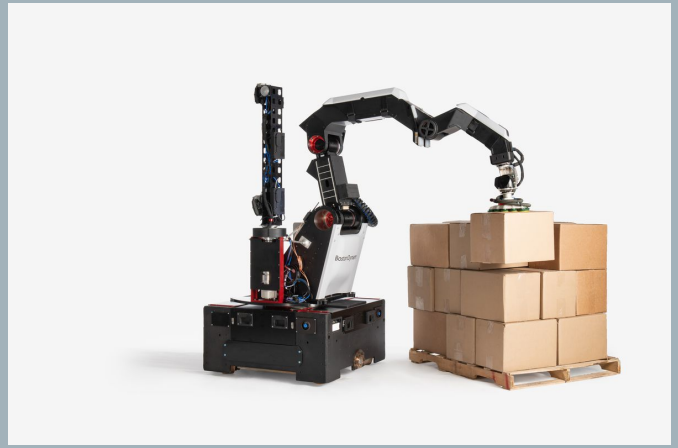
Use Case

- Transporting pallets around warehouse and factory floors
- **Increased efficiency** with multiple **collaborative robots**

ECE Areas: Circuits, Software Systems, Signals & Systems



Amazon Robotics (top), Boston Dynamics (bottom)

Requirement #1:
Pick-Up and Drop-Off Pallets

Motivation:

Load trucks optimally for upcoming route

Sub-Requirements:

1. **Differentiate (100% accuracy)** and **localize (5mm)** different pallets
2. Pallets should be dropped off in the **correct order**
3. Accurately localize robots to **5mm** precision

Requirement #2:
Efficiently Scale to Multiple Robots

Motivation:

Algorithms should scale to multiple robots to represent real world scenarios

Sub-Requirements:

1. **Collision-Free** planning
2. **2.5x speedup** with 5 robots when compared to 1
3. Max computation time of **1 second** for sense-plan-act loop

Requirement #3:
Misc Robot Requirements

Motivation:

Other requirements our robot should satisfy

Sub-Requirements:

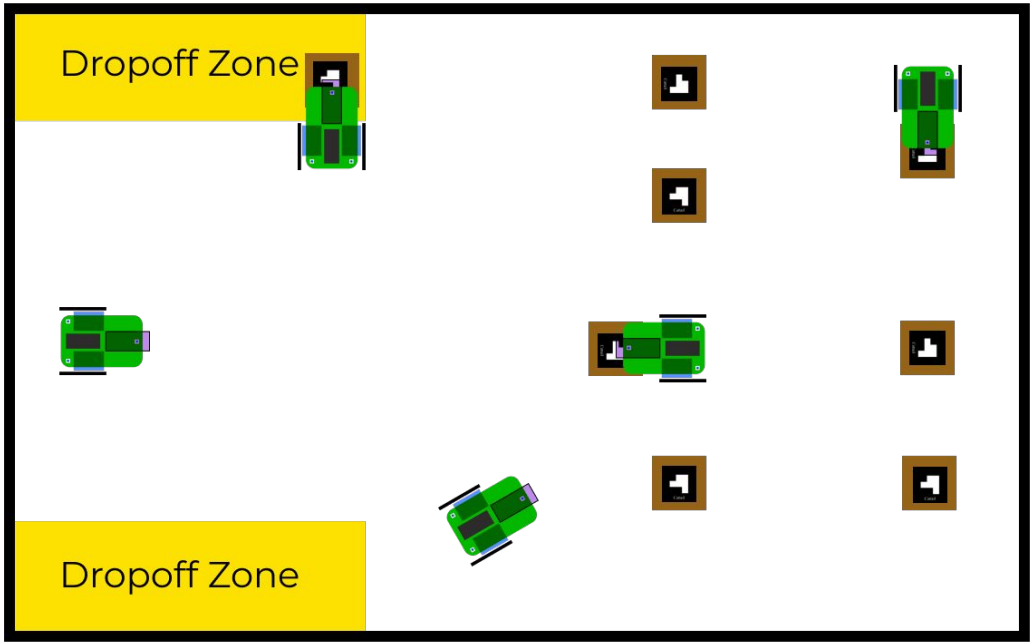
1. **4 hours** of battery runtime
2. Ability for robot to **reliably** pick-up/drop-off pallets
3. Communication latency of **under 100 ms**

Challenges

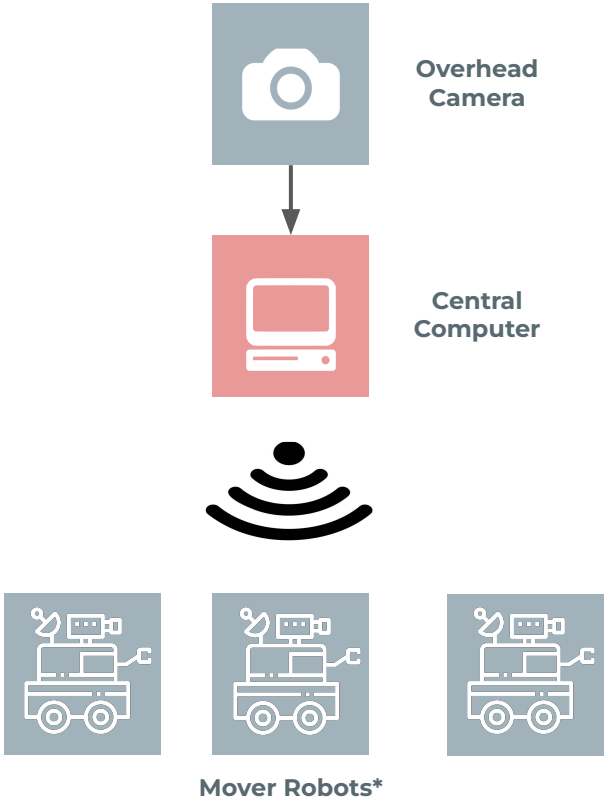
How do we...

1. **coordinate** the motion of the robots?
2. **track** of the positions of all objects in our environment (i.e. pallets and robots)?
3. **move** pallets from one location to another?
4. **optimize** the placement of the pallets?

Solution



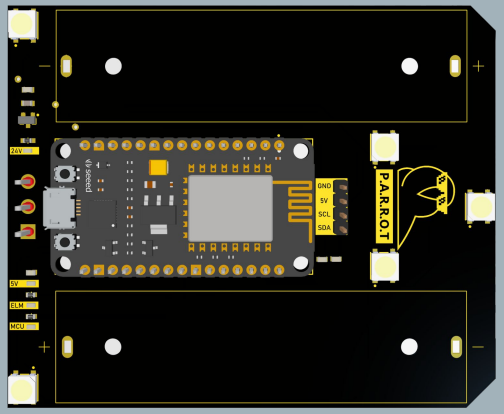
Mockup of Field



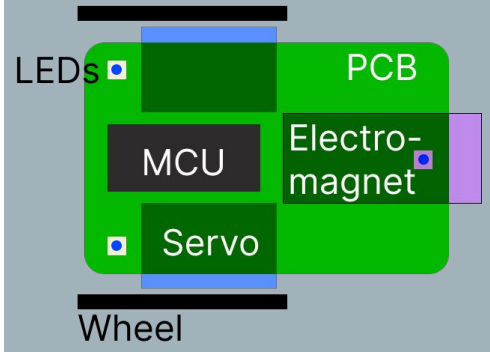
*for visualization purposes only. Not our actual robots.

The Robots

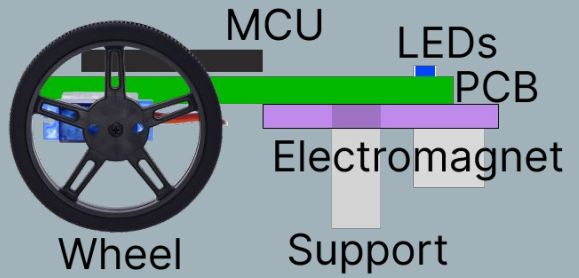
- ESP8266 MCU+Wi-Fi for **communication**
- Electromagnet to **pick-up** pallets
- 2 continuous rotation servos as powertrain
- NeoPixels for **localization**
- 2 18650 cells for **power**



PCB Schematic for Robot



Robot Top View



Robot Side View

Testing & Verification

Computer Vision Tests: Place several pallets/robots on field and test position detection accuracy

Planner/Controller Tests: Plan and execute motion for several start/goal pairs

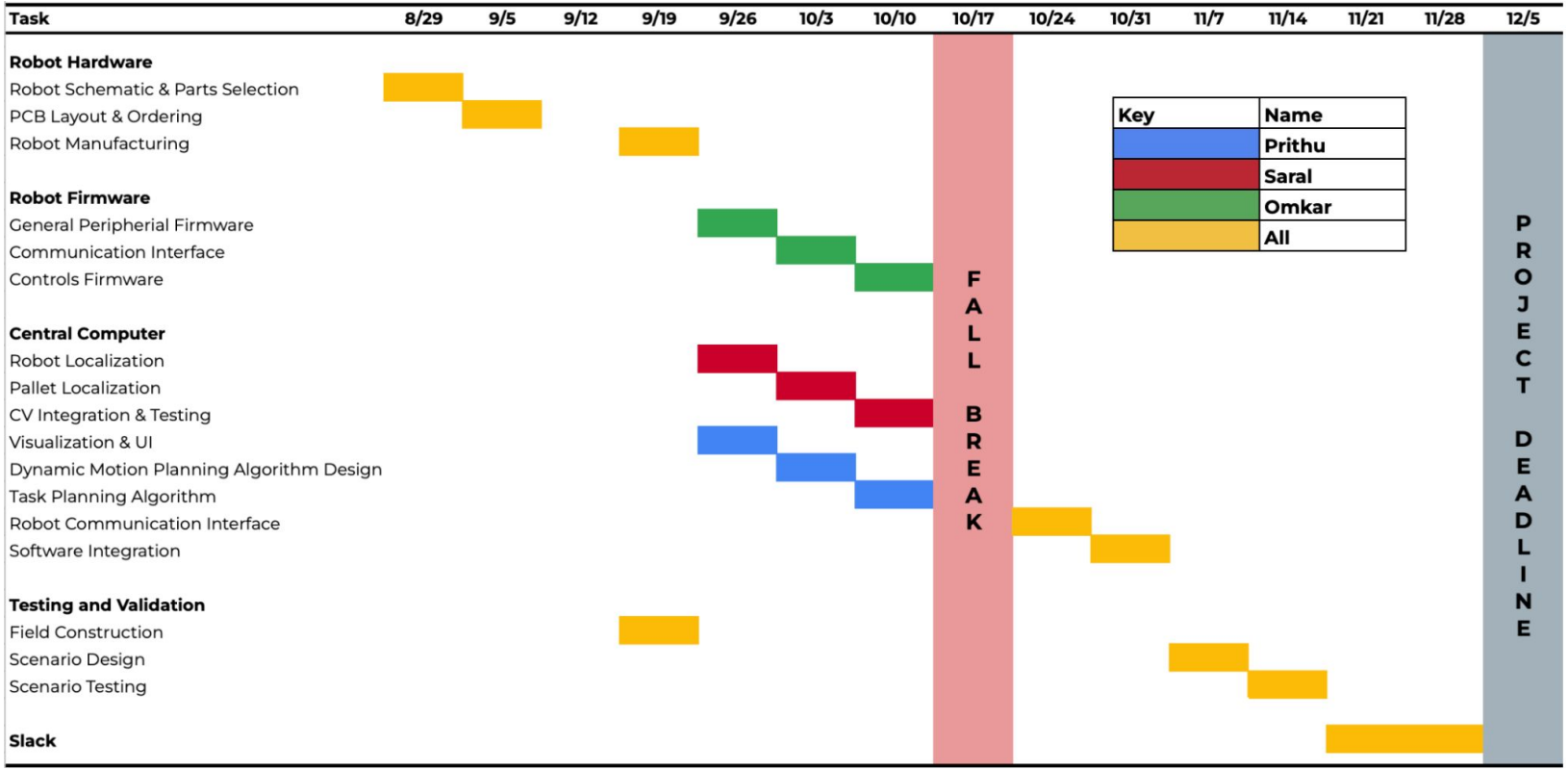
Pickup/dropoff tests: Test various approach angles on robot

Efficiency Tests: Test two scenarios with varying number of robots to see speedup

Tasking

- **PCB Design** (Saral & Omkar)
- **Robot Manufacturing** (All members)
- **Robot Firmware** (Omkar)
- **Computer Vision Software** (Saral)
- **Motion & Task Planning** (Prithu)
- **Robot Communication Interface** (Prithu & Omkar)
- **Software Integration** (All members)
- **Field Construction** (All members)
- **Scenario Design & Testing** (All members)

Schedule


Task
8/29
9/5
9/12
9/19
9/26
10/3
10/10
10/17
10/24
10/31
11/7
11/14
11/21
11/28
12/5
Robot Hardware
Robot Schematic & Parts Selection
PCB Layout & Ordering
Robot Manufacturing
Robot Firmware
General Peripherial Firmware
Communication Interface
Controls Firmware
Central Computer
Robot Localization
Pallet Localization
CV Integration & Testing
Visualization & UI
Dynamic Motion Planning Algorithm Design
Task Planning Algorithm
Robot Communication Interface
Software Integration
Testing and Validation
Field Construction
Scenario Design
Scenario Testing
Slack
FALL BREAK
PROJECT DEADLINE
Key
Name
Prithu
Saral
Omkar
All

Conclusions

- Proposed **multi-robot** system to **organize** pallets in warehouses (scaled down)
- Hope to provide increased collision-free **efficiency**
- Plan to **test** with several packing scenarios