Progress Review 3

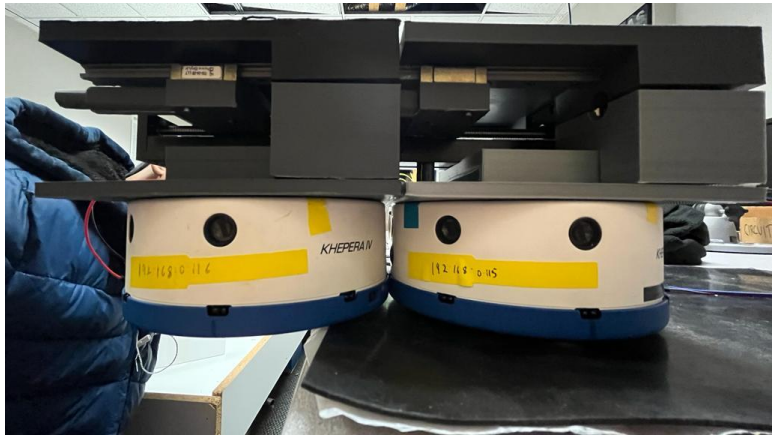
Team A: Mind The Gap

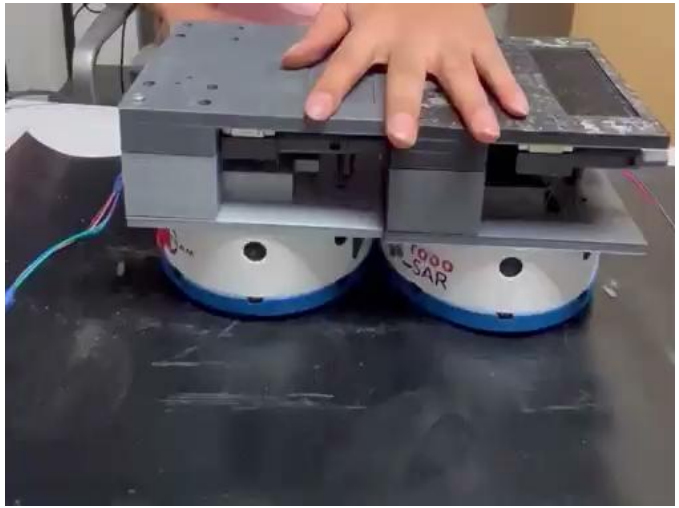
Agenda

1. Subsystem Updates
    a. Coupling Electro-Mechanical System
    b. Low Level Controller and Simulation Environment
    c. Planner
    d. Task Allocator
2. Risk Mitigation
3. Subsystem Demonstration - Collision-Free Paths on hardware
4. Subsystem Demonstration - Coupling and locking mechanisms

Coupling Mechanism

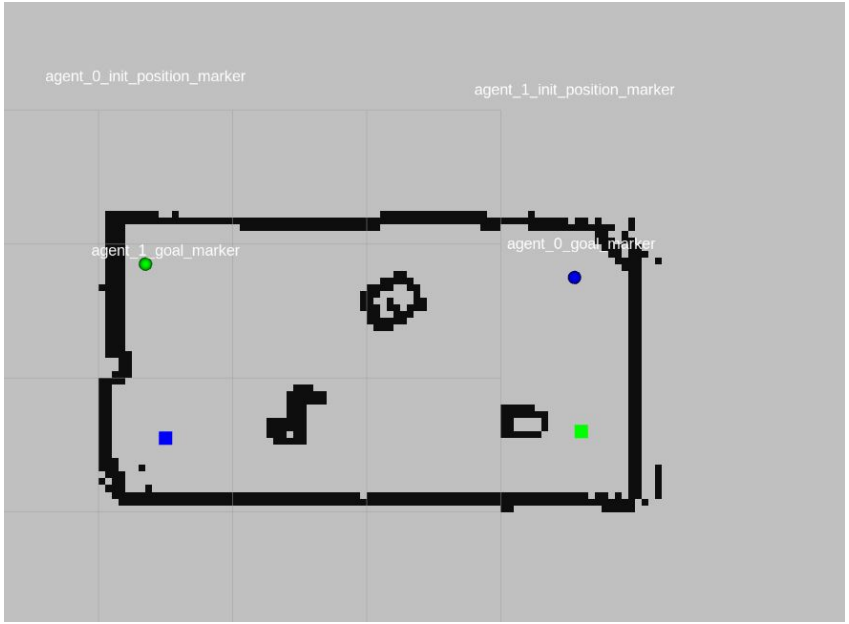
- Prototyped the 2nd agent
- Tested the coupling sequence manually
- Conducted coupling load tests





Low-level Controller and Simulation Environment

- Implemented PID controller and time synchronization (Waiting for slowest) to avoid collisions
- Implemented interactive marker based Rviz stuff for ease of experimentation



Planning

Work done for PR3:

- Replaced low level A* search with Theta * planner with time and space constraints
- Added time synchronization based on robot kinematics to avoid collisions in CBS
- Integrated and ran single and multi-agent planners on Khepera

New Challenges Identified:

- Time synchronization based on linear kinematics - differs from controller output (PID)
- Collision boundary boxes are not consistent across runs
- Runs very slow due to small time discretization

Goals for PR 4:

- Improve performance and avoid collisions 75% of the time
- Integrate with gap-aware task allocator
- Test on hardware, preparing for SVD

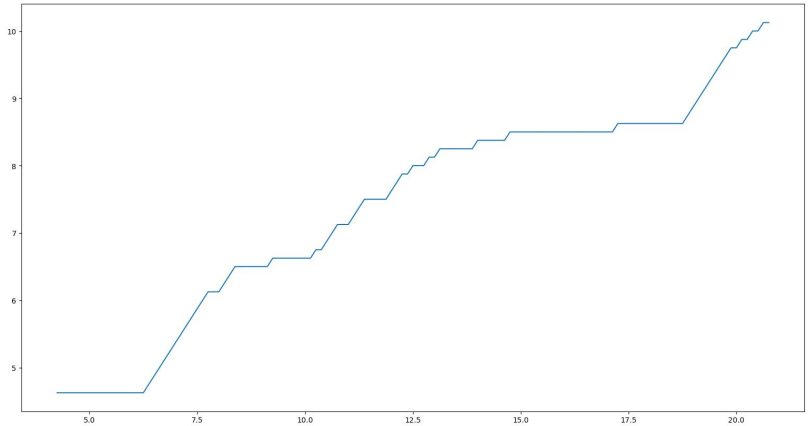


Fig 1: A* Path for single agent

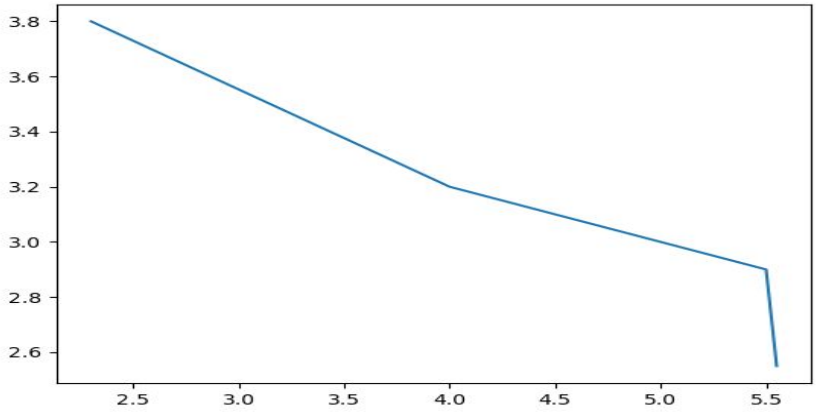
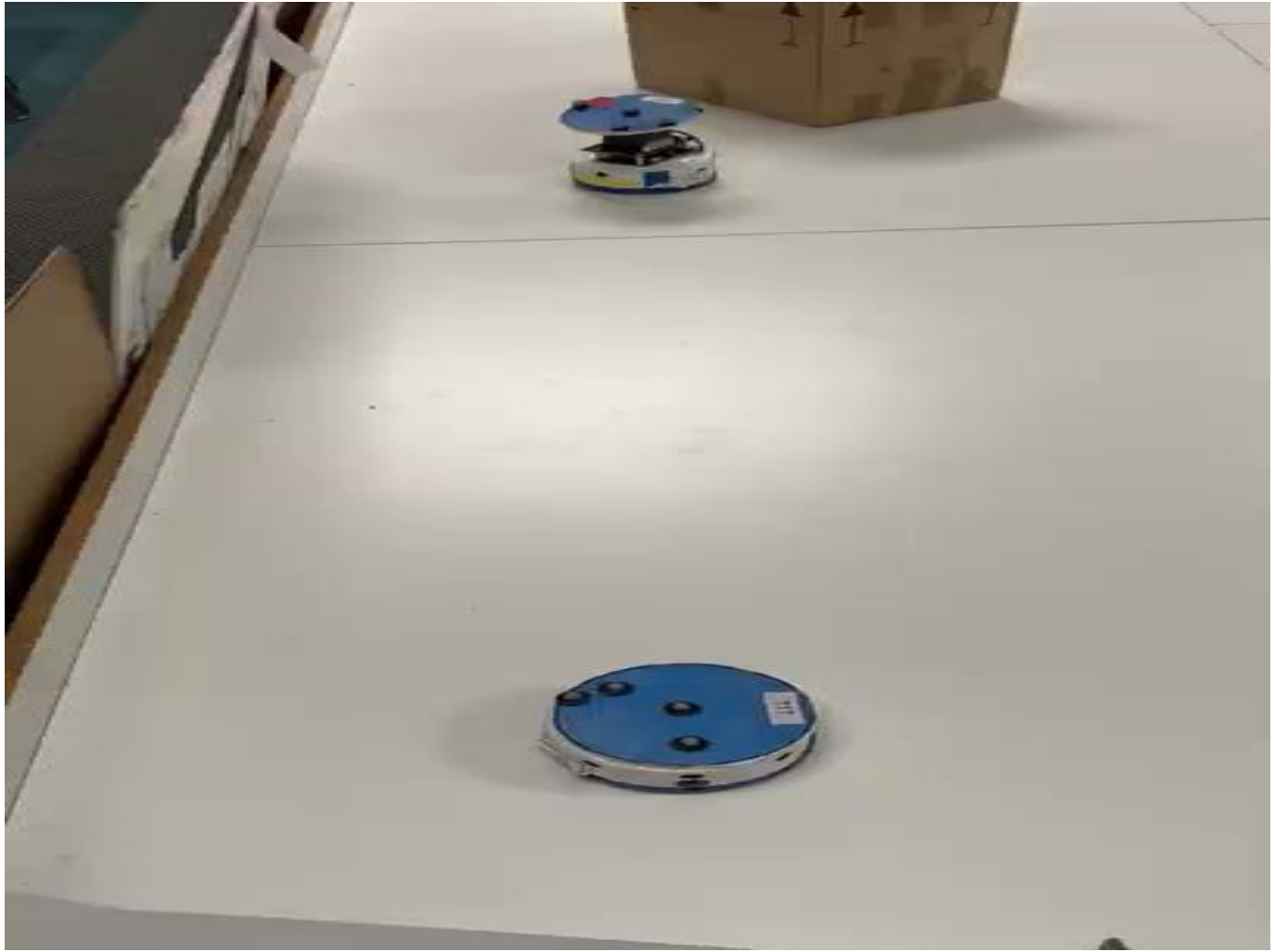


Fig 2: Theta* Path for single agent



Task Allocation

Work done for PR 3:

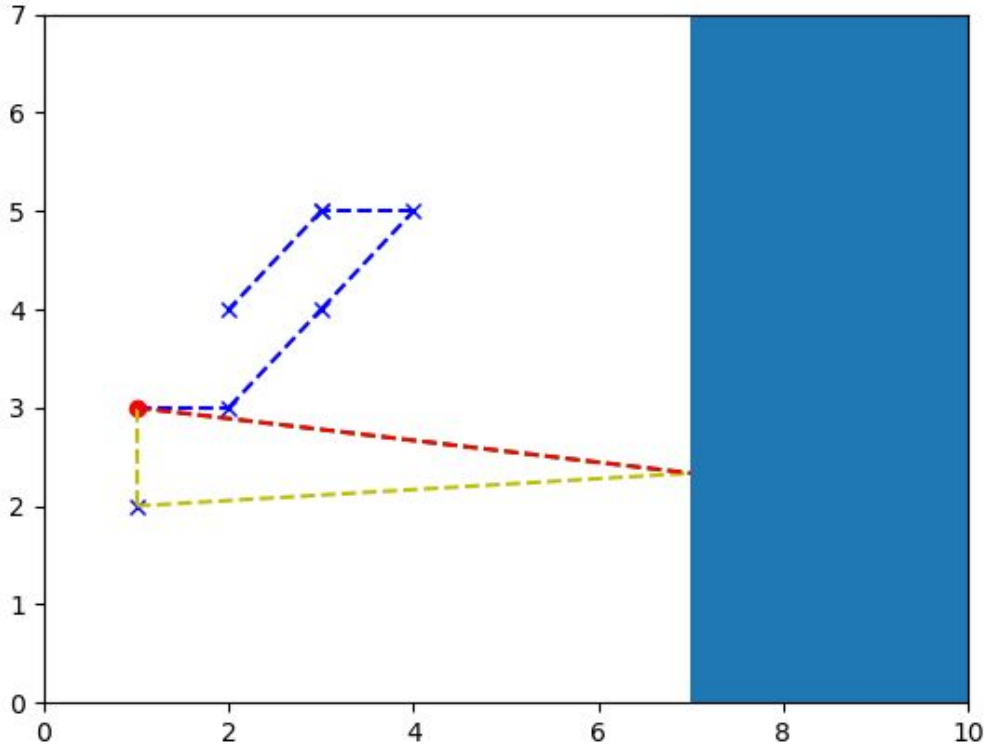
- Re-implemented task allocator using Google OR tools for many-to-one tasks-robot.
- Hierarchical task allocator models POI exploration as a vehicle routing problem (VRP)
- The best point of gap crossing is determined for a gap of a fixed size, relative to the location of the last POI allocated for that agent
- A coalition of robots is allocated for the gap crossing task
- The gap crossing task is added to the task lists of selected agents.

Challenges:

- Output must be configured for the planner
- Handling various gap locations/configurations.

Goals for PR 4:

- Integrate and test task allocator with all other subsystems



Route lengths
Task lists
(100 is the gap crossing task)

```
[6.036923425424944, 6, 8.009252125773315, 6.036923425424944]
[[0, 100], [0, 5, 2, 6, 7, 4, 3], [0, 1, 100], [0, 100]]
```

Risk summary - Current Risks

Risk Title: Khepera on-board GPIO not working	**Risk Owner:** Sankalp
Risk Title: Unexpected interference of mechanism or enclosure with Khepera sensors (cameras/IR)	**Risk Owner:** Sankalp
Risk Title: Enclosure Breaks During Testing	**Risk Owner:** Sankalp
Risk Title: Suitable voltage and current to each components with a battery and the designed PDB	**Risk Owner:** Sudhansh / Sankalp
Risk Title: Proposed SVD setup might be unsuitable	**Risk Owner:** Dhanvi