



# COOPERATIVE AUTONOMOUS DISTRIBUTED ROBOTIC EXPLORATION (CADRE) R&D



STUDENTS: YILIN LIU, JOHN BRUGATO, JINGHUI SONG, JACK CHUANG

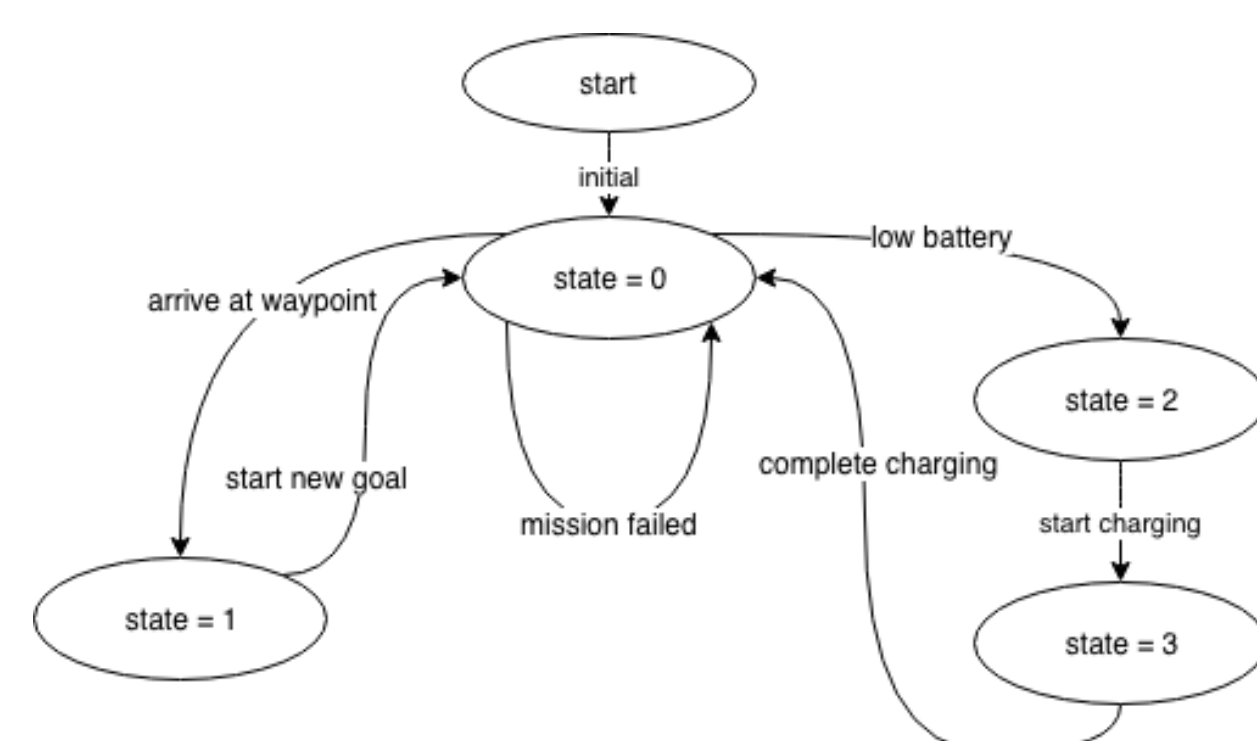
## INTRODUCTION

- CADRE project is developing a network of shoe-box-sized mobile robots called **PUFFER** that could enable future autonomous robotic exploration of Moon, Mars... etc.
- Each robot contains an onboard **computer, wireless radio and camera**
- In this project, we divided to **software team** who in charge of the formation control and the **hardware team**.



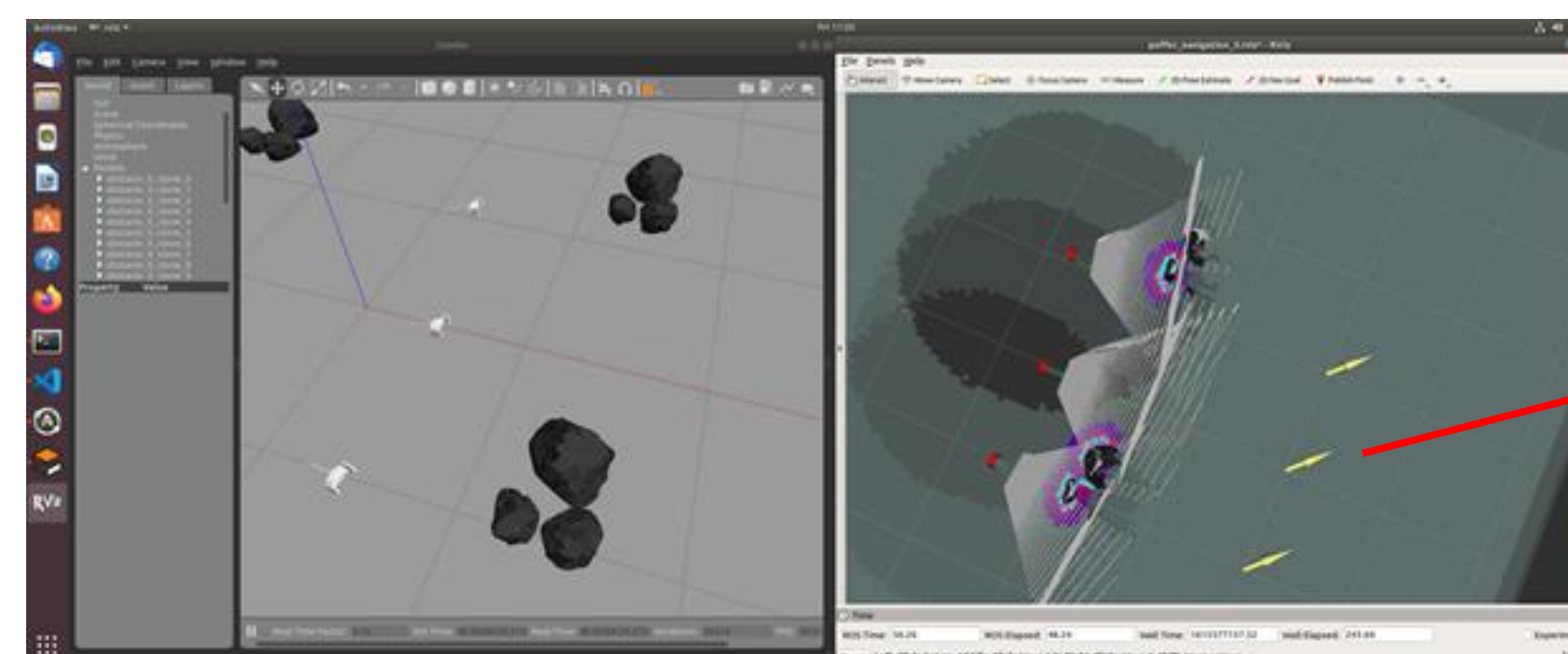
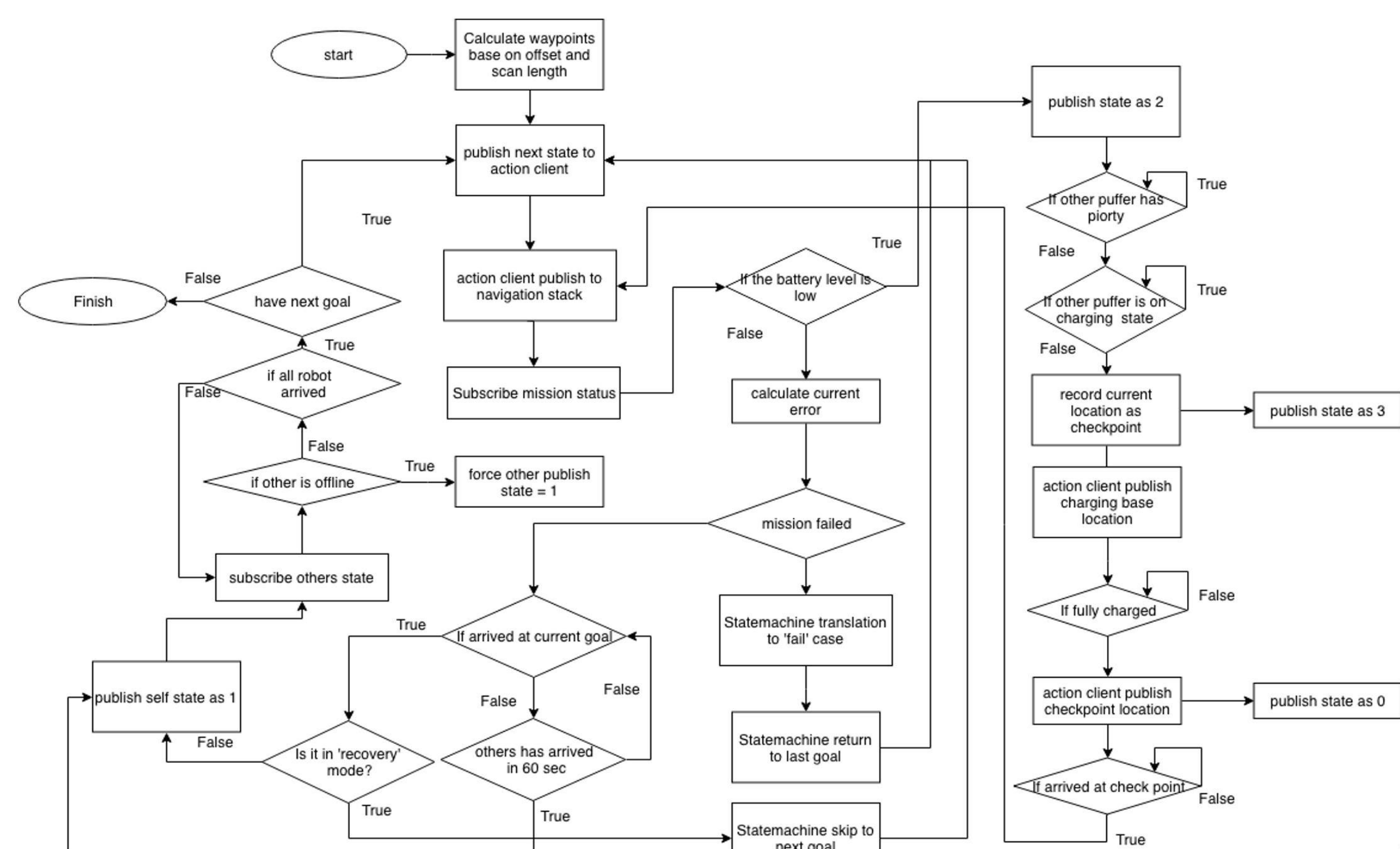
## FORMATION CONTROL

- The distributed measurement techniques require robots to autonomously explore unknown places while **maintaining a specific formation**.
- Develop parametric formation control algorithms using **ROS**.
- Each PUFFER will publish message to talk to other PUFFERS.



## WAYPOINTS MODE

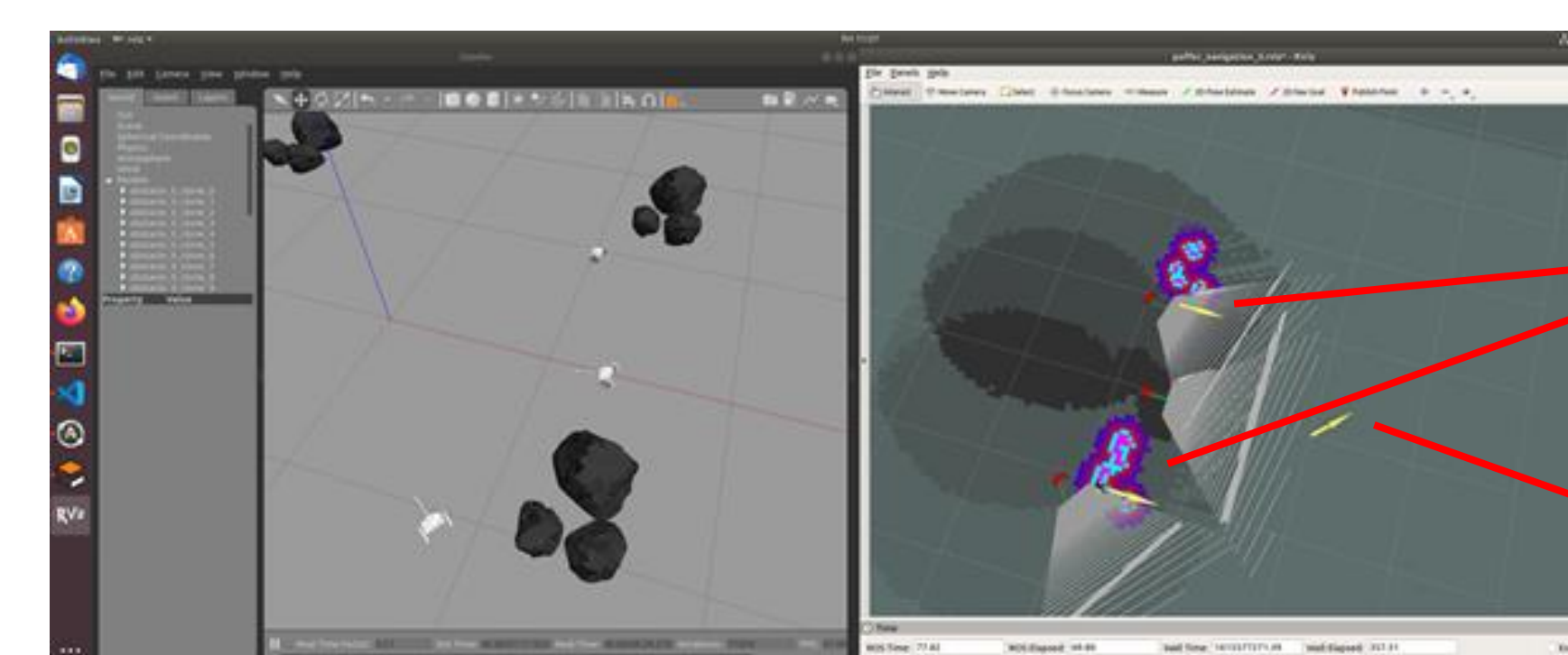
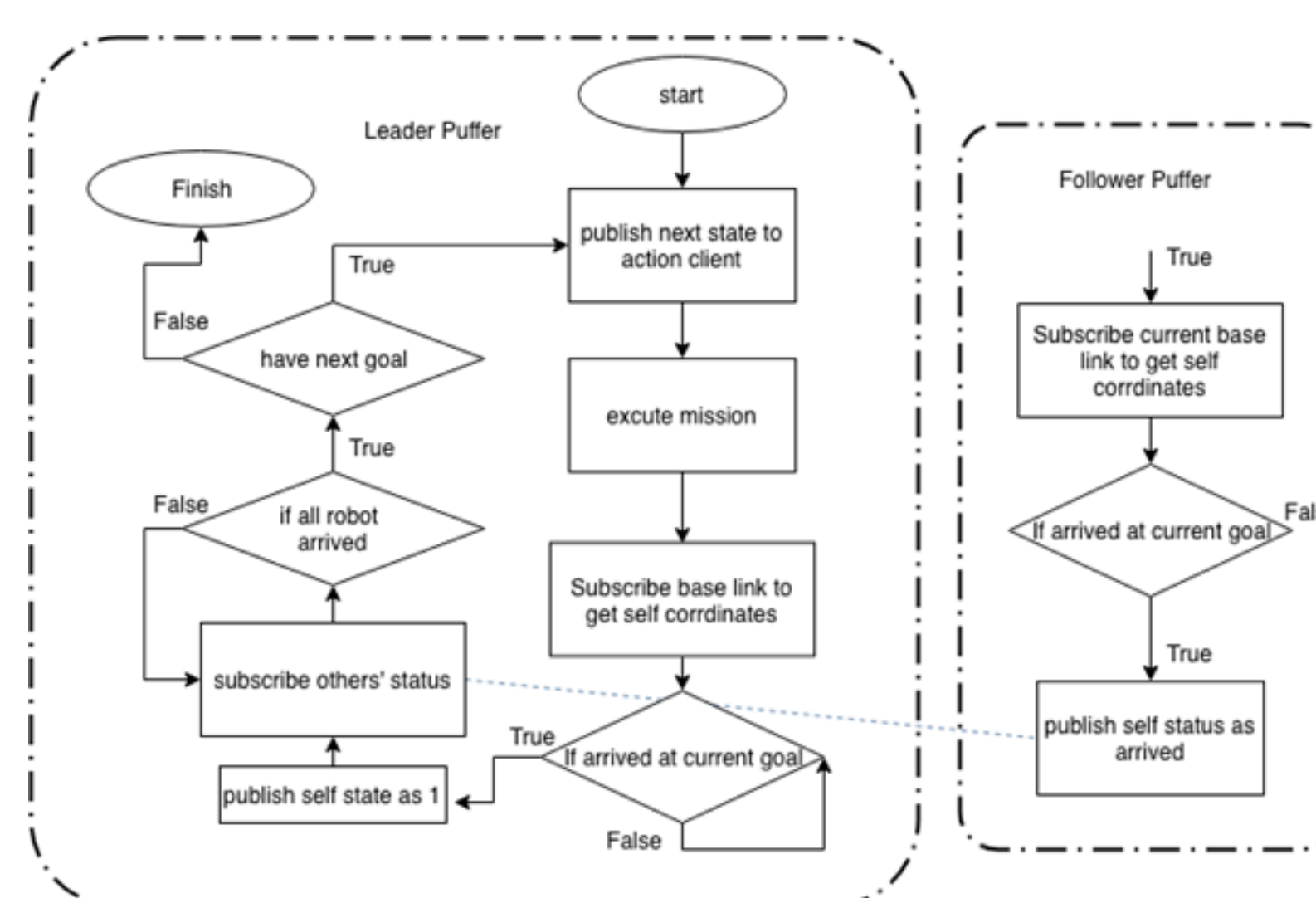
- Each puffer will **calculate individual trajectory** based on the given offsets between the puffers and the scan length.
- The puffers will reach each checkpoint in a synchronized manner.



Goal is given individually

## LEADER-FOLLOWER METHOD

- Use the Lyapunov control
- The **leader PUFFER** will follow the **given waypoints** and followers will go to the **calculated point** based on the given offsets and bearing angles derived from the leader's position.
- The leader puffer will wait for the follower to reach each checkpoint before setting off for the next goal.

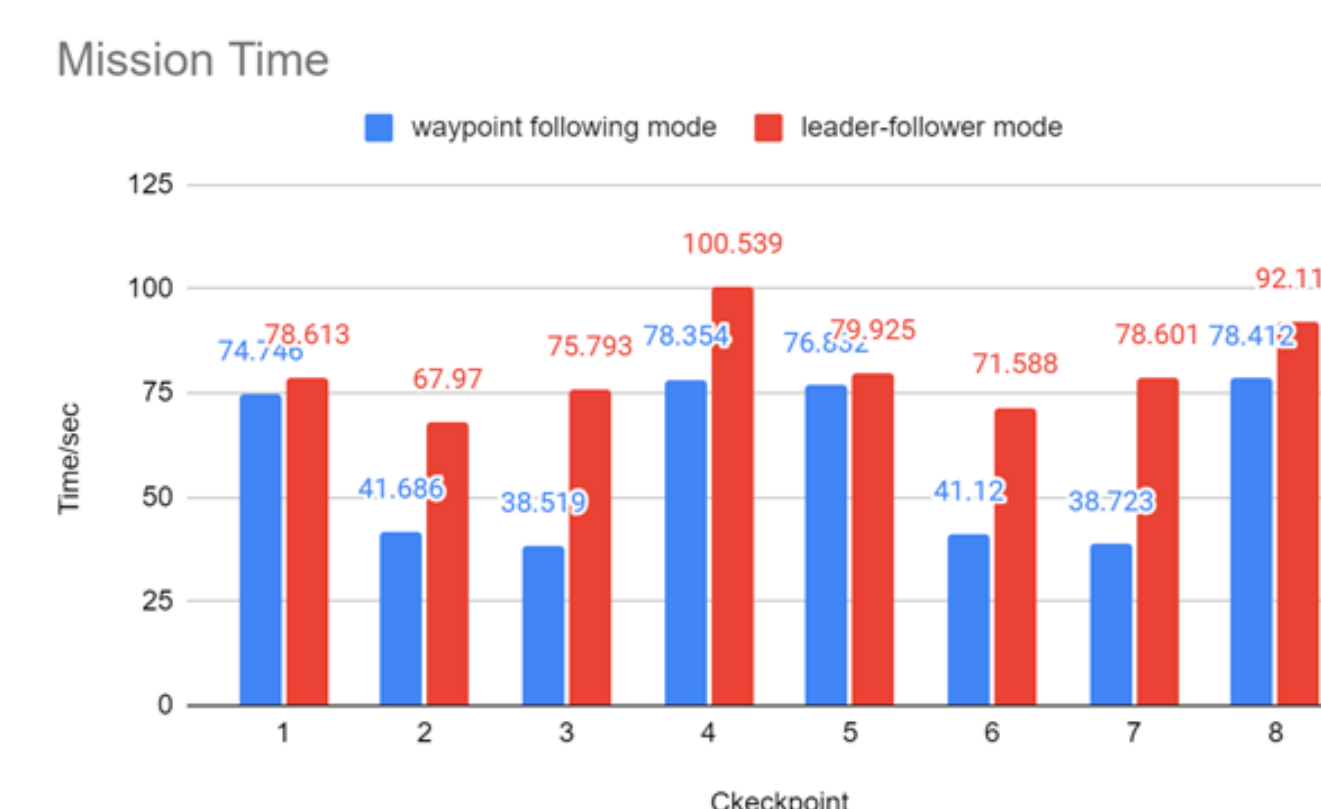
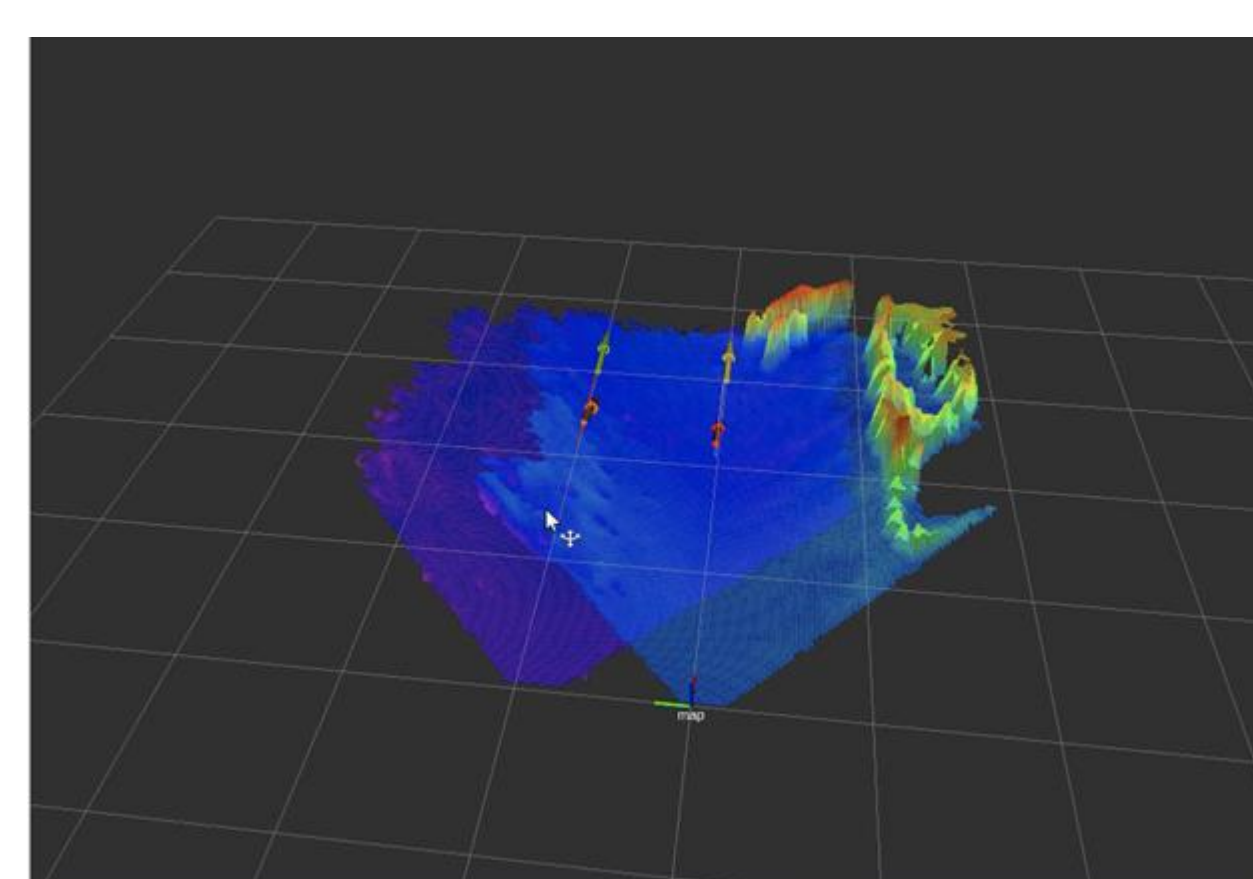


Followers follow the leader

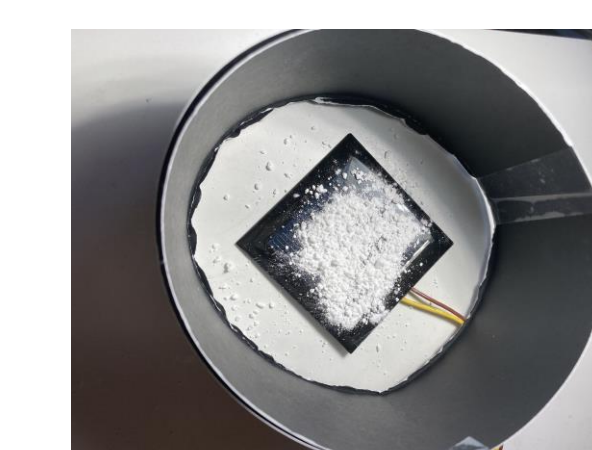
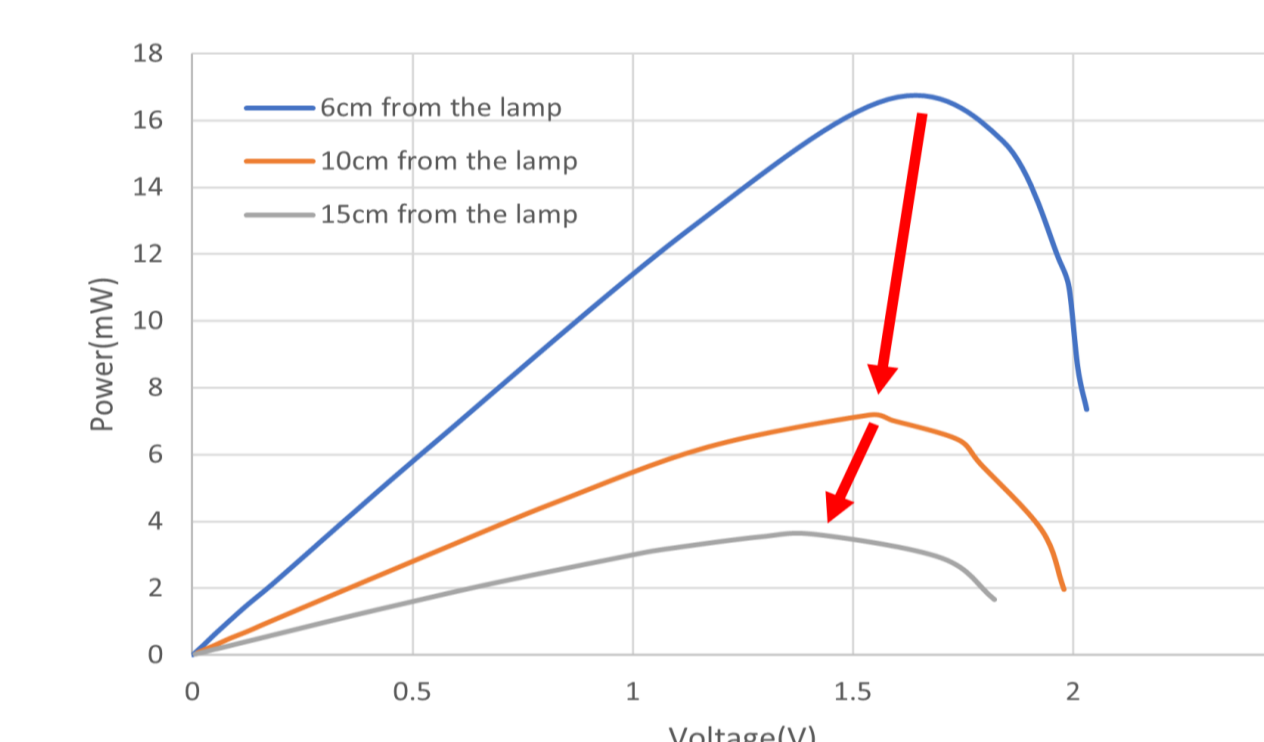
Leader is given the goal

## FORMATION SIMULATION

- Obstacle detection in the simulation environment Gazebo by the camera.
- The simulated mission time of **waypoint mode** is less than leader-follower mode.



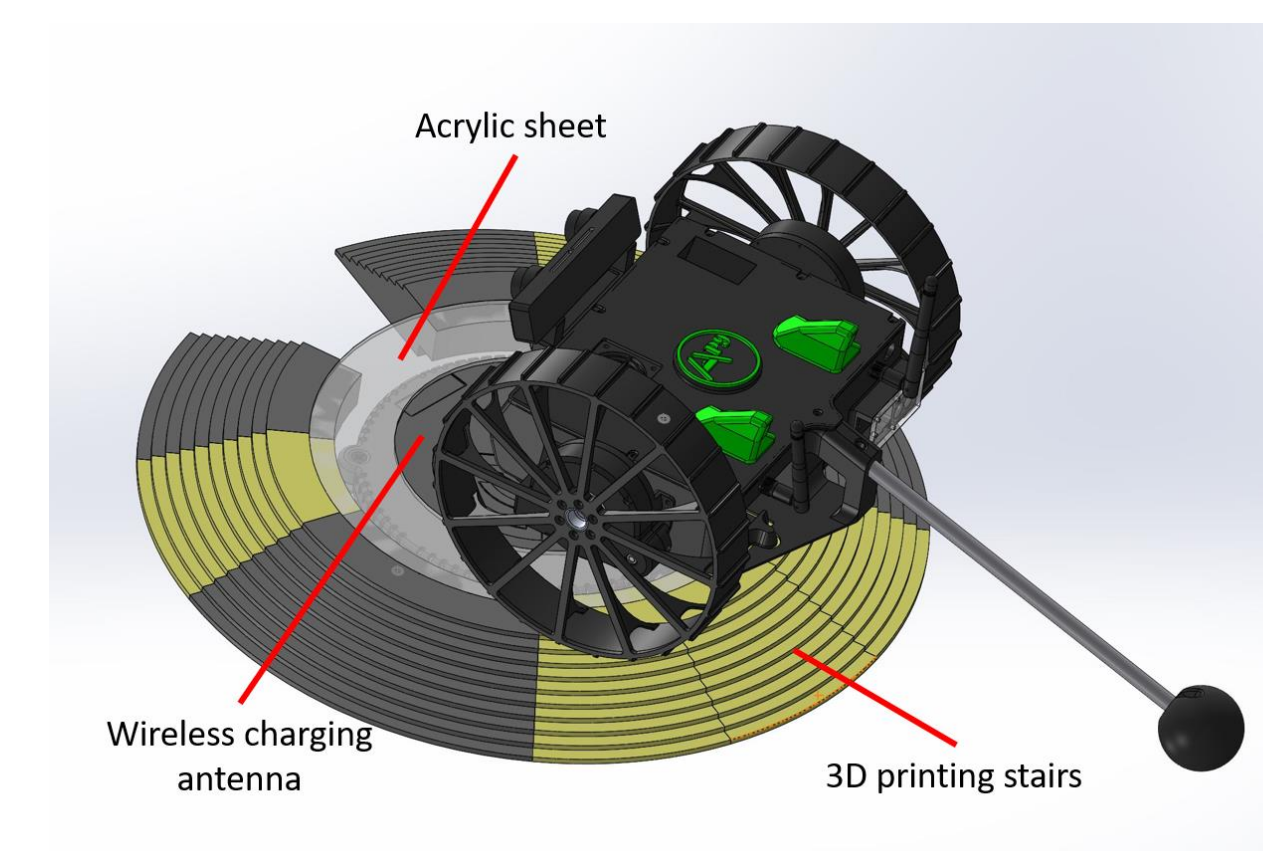
## DUST ACCUMULATION DETECTION



- Utilize the change of solar cell characteristics, which is the **power peak and corresponding voltage**, at different light intensity to detect the dust accumulation.
- Use rosserial to communicate with PUFFER about current environment condition.
- The experiment setup is with fixed light source and add flour gradually to see how the dust will affect solar cell output.

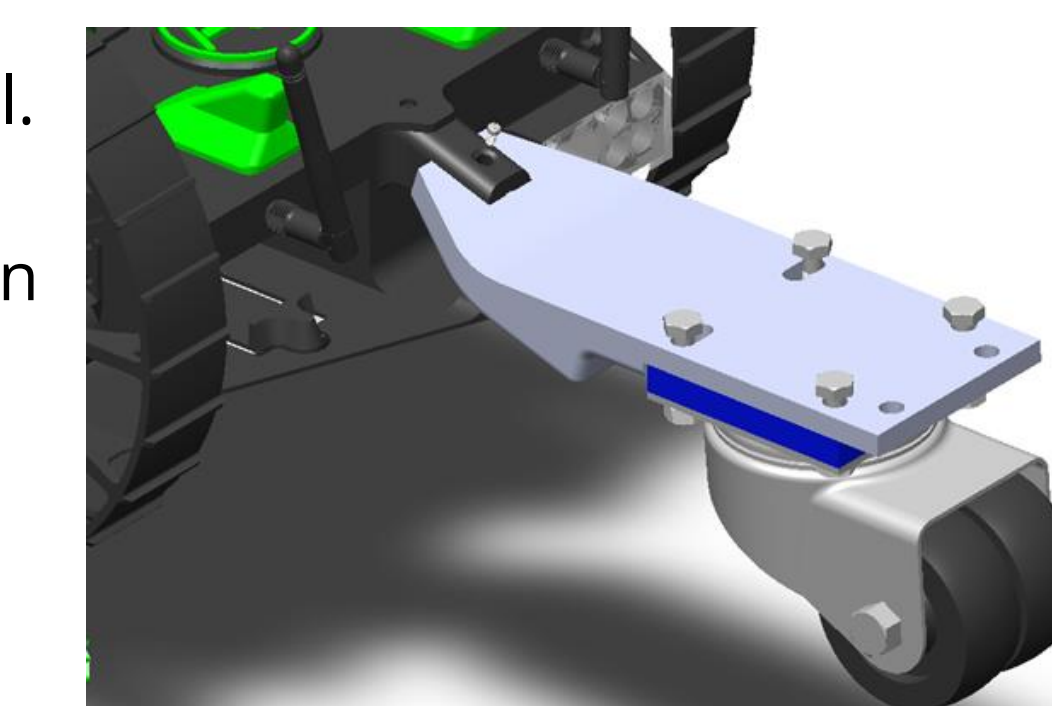
## WIRELESS CHARGING PLATFORM

- The wheel track of PUFFER is slightly smaller than the wireless charging antenna, so the platform for it to drive over it is needed.
- The PUFFER can climb up from 330 degrees.
- The maximum distance from the receiver and antenna is approximately 10cm.



## TAIL AND CASTER WHEEL

- The current design of PUFFER utilizes a rigid ball as tail.
- Caster wheel is chosen in hope of improving the traction and **preventing the rover flipping over** when going downhill by shifting center of gravity back.
- Allows the PUFFER can **directly move backward and pivot better**.



## FUTURE WORK

- Integrate the simulated results into real PUFFER successfully.
- Use the PCB to integrate the result of solar cell into the rover.
- Test different caster wheels to see if and/or which perform better than previous design in terms of mobility.

