EPFL

sycamore lab

SYSTEMS CONTROL AND MULTIAGENT OPTIMIZATION RESEARCH

# SEMESTER PROJECT
-
# FINAL PRESENTATION

## COORDINATION AND CONTROL OF A GROUP OF GROUND ROBOTS

# Motivation

## What ?

Create a practical testing environment :

- Flexible
- Modulable
- Easy to use  / Easy to setup

## Why ?

- No existing open-source projects with JetBots and multi-agent control
- Enable real life conditions testing

## How ?

- ROS2
- Jetbots
- Optitrack

# Background

- ROS2
  - Robotic Operating System
  - Set of software libraries and tools for building robot applications
  - Real-time control
  - Added support for multi-robot system

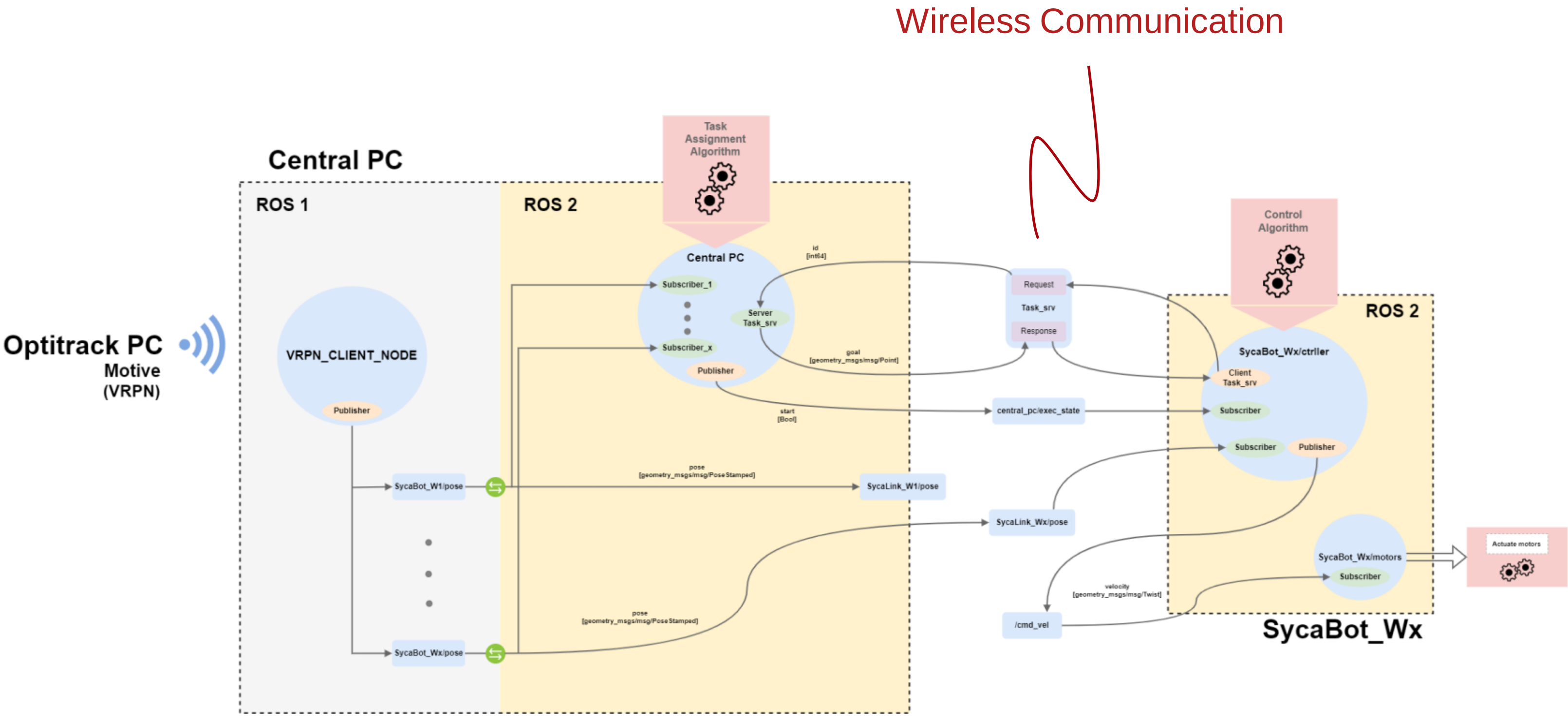
- Jetbot
  - Open-source ground robots
  - NVIDIA Jetson Nano
  - GPU
  - Camera

# Challenges

- ROS2
  - Network connection
  - Architecture
  - Real time position tracking
  - Flexibility
  - Easy to use / to setup

- Jetbots
  - OS configuration
  - Control
  - Task Assignment [TA]
  - System compatibility

# General architecture



# TA & Control

## C-CAPT with N robots and M goals & LQR

### C-CAPT with N robots and M goals

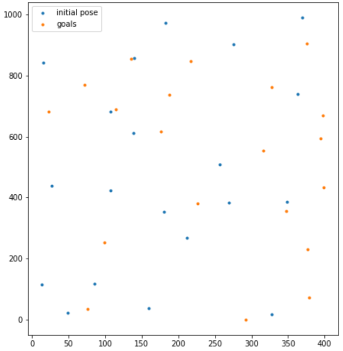
**Do** : generate M>N goals spaced by $\Delta$

**While M>N** : Remove one goal randomly

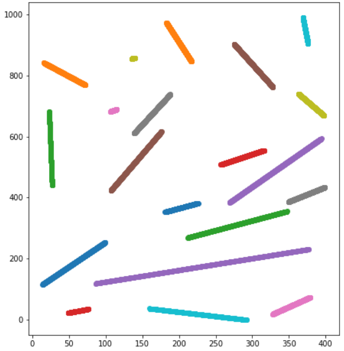
**Compute** : $D_{i,j} = \|x_i(t_0) - g_j\|^2 \quad \forall i \in \mathcal{I}_N, \forall j \in \mathcal{I}_M$

**Solve** : $\phi^* = \underset{\phi}{argmin} \sum_{i=1}^{N} \sum_{j=1}^{M} \phi_{i,j} D_{i,j}$

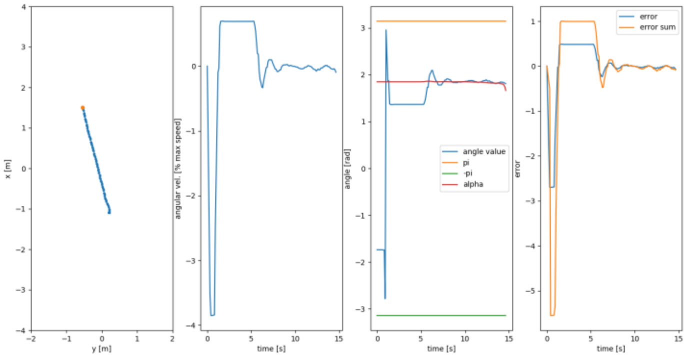
**Initial poses and goal locations**



**TA with N=20 and $\Delta = 2\sqrt{2}R$**



### Discrete LQR



$$\min \sum_{k=0}^{\infty} J_k = \mathbf{x_k^T} Q \mathbf{x_k} + u_k^2 R$$

$$\begin{bmatrix} e^{\theta}_{k+1} \\ e^{\theta_i}_{k+1} \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ T_s & 1 \end{bmatrix} \begin{bmatrix} e^{\theta}_{k} \\ e^{\theta_i}_{k} \end{bmatrix} + \begin{bmatrix} T_s \\ T_s^2 \end{bmatrix} u_k$$

$$u_{k+1} = c^{\theta}_k e^{\theta}_k + c^{\theta_i}_k e^{\theta_i}_k$$

Matthew Turpin, Nathan Michael, and Vijay Kumar. “Capt: Concurrent assignment and planning of trajectories for multiple robots”

# Demonstration

# Open issues – Future work

- Open Issues
  - Wireless communication
  - Docker

- Future work
  - MPC
  - Safe learning
  - Cameras
  - Performance analysis

# Thank you for your attention