Project Description

The project aims to design and implement a **multi-robot system** in a **2D/3D simulated environment**, integrating the **Robot Operating System (ROS)** with either **Gazebo** or **Unity** as the underlying simulation platform. The goal is to reproduce realistic, collaborative behaviors among heterogeneous robots that cooperate to accomplish a shared mission within a complex and dynamic environment.

Tasks will be to model the environment, define robot behaviors, and simulate multi-robot coordination strategies for perception, navigation, and task execution. Depending on your requirements, you can **select one of the following simulators**:

- **Gazebo-based implementation**

  Minimum Hardware Requirements:
  Processor (CPU) — Quad core Intel i5, or equivalent
  Memory (RAM) — 4 GB or more
  Graphics card (GPU) — Dedicated GPU with 1 GB or more graphics memory
  Disk space — At least 500 MB free disk space

- **Unity-based implementation**

  Minimum Hardware Requirements:

CPU	4 Cores (vCPU)
RAM	16 GB
Storage	100 GB SSD
GPU	1 GB Dedicated GPU Memory

- **Search for another 2D/3D simulator that meets your requirements**

- **In case of technical issues, you can also avoid graphical simulators**

After selecting the simulator, you can choose from one of the proposed **application scenarios**, each representing a different real-world context where multi-robot coordination is essential:

(although it is possible to pick the same scenario for multiple projects, it is preferable to avoid it)

Drone Rescue

We consider the use of drones with automated flight plans to survey an area affected by an earthquake. The simulation incorporates environmental variables such as wind speed and ground elevation, which influence flight performance and route optimization. Users receive real-time feedback on key metrics like the estimated time required to scan the area and the overall feasibility of the flight plan. Since the affected site is extensive, deploying a coordinated fleet of two or more drones ensures full coverage and enhances the efficiency and sustainability of the operation.

Smart Agriculture - taken
We consider farm management activities, including planting, irrigation, and harvesting, with a focus on the use of robots in smart agriculture scenarios. The movement and behavior of these robots may vary depending on the terrain and the type of machine employed. Different operational contexts can be defined, such as areas designated for irrigation, planting, or harvesting, based on the attributes of the land.

Smart Health - taken
Patient management within a hospital involves a wide range of interconnected processes, from medical visits to emergency interventions. For example, it may start with an ambulance rescuing a patient and transferring them to the hospital, where nurses welcome the patient and carry out initial assessments or routine check-ups. Doctors then manage visits, consultations, and diagnostic activities, while specialized medical teams coordinate complex procedures such as surgeries in the operating room.

Emergency Management
We consider scenarios in which firefighters, robots, and sensors support the operations of rescue teams during emergency situations. For instance, in the case of a fire, an earthquake, or people trapped under debris, both the environment and the movement of individuals play a critical role. Safe zones and unsafe zones must be identified, and emergency exits must guide evacuation paths.

Smart City - taken
We consider city-related services such as tourism management, vehicle and bike rentals, taxi transportation, and restaurant activities. Urban mobility further includes the coordination of public transport, traffic flows, traffic lights, pedestrians, and individuals with different mobility needs. Examples range from buses and taxis picking up passengers, to citizens using shared vehicles to navigate the city.

Smart University - taken
We consider university-related logistics, focusing on library services and tutor support for students.

Smart Logistics - taken
We consider warehouse management processes, including ordering, storage, and the transportation of goods. This involves the organization of warehouse space, the retrieval of items, the loading and unloading of vehicles, and the delivery of products from the warehouse to the customer's home.

Smart Airport
We consider the management of passenger movements within an airport, which is strongly influenced by zones of accessibility. For example, once a passenger has passed through security checks, they cannot return to the departure hall but must remain within the gate area. This also introduces the idea of providing a space view that depends on the role of the participant.

Space - taken

We consider the management of robots operating on the lunar surface. These robots are designed to move within specific locations identified for excavation, based on areas selected by humans through the analysis of satellite images. Once deployed, the robots navigate the designated zone to collect at least five samples, which are then analyzed and transmitted back to Earth. After completing their sampling task, the robots return to the base station for recharging, ensuring continuity of operations.

Amusement Park
This case focuses on an amusement park where, based on the satisfaction level of visitors, people are more likely to choose one attraction over another. It may consider aspects such as queue management and area occupancy.

As a result, the project will involve the **execution and collection of data** from simulated runs of robot behaviors under different operational conditions. You should be able to **simulate multiple test cases**, introducing **variability and uncertainty** (e.g., sensor noise, unexpected obstacles, changing environmental conditions, or communication delays) and gather data in the form of logs.