## Background & Motivation

Inspired by biological systems such as ants and bees, our project explores the integration of swarm robotics with path planning algorithms. Our goal was to design a decentralized, efficient robotic system for real-world applications like search and rescue.

With the help of simulations in ROS and Gazebo, our swarm leverages PSO for coordination and RRT*/TEB for path planning and obstacle avoidance. This marks a new chapter in collaborative robot navigation.

Objectives

- Develop a robust simulation combining swarm robotics and path planning
- Analyze performance in dynamic environments
- Explore decentralized control mechanisms
- Lay groundwork for future real-world deployment
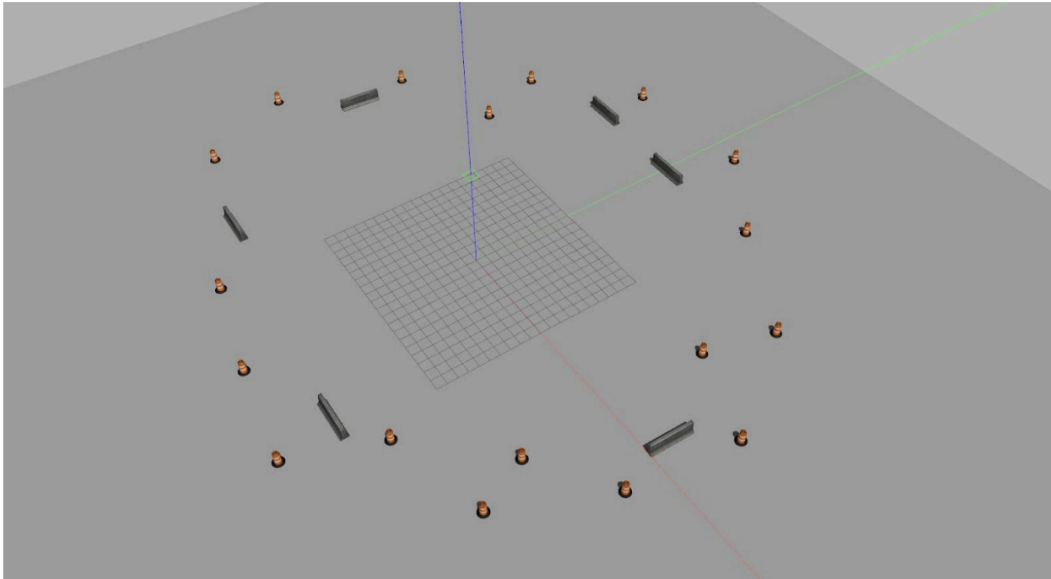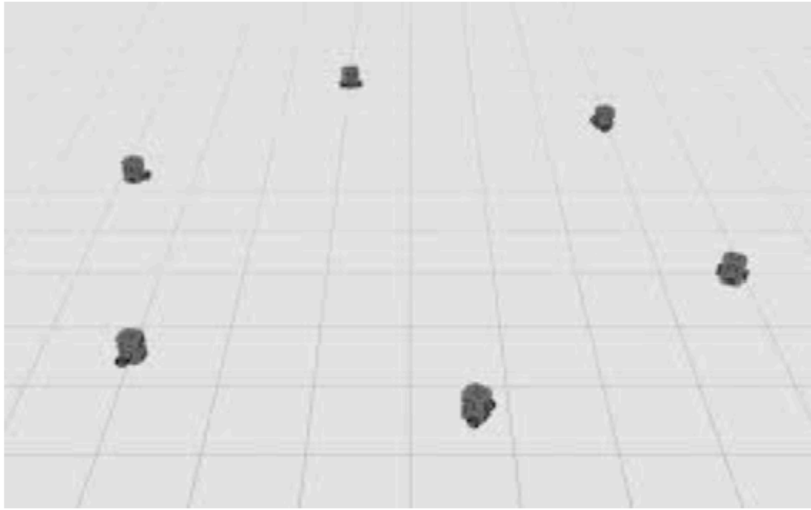
Methodology

Our robots initialize in a Gazebo-simulated world using ROS. Each uses the RRT* algorithm for global planning and TEB for local adjustments. PSO coordinates the swarm behavior, enabling robust obstacle avoidance and path optimization.

```
class Particle:
    def update_velocity(...):
        # PSO logic

def rrt_star(...):
    # Node expansion for path finding
```

Results & Analysis

Robots demonstrated smooth coordination and effective navigation around obstacles. Simulated results confirmed the efficiency of decentralized control and advanced planning strategies.

Future Work

Future development includes hardware implementation, adaptation for highly dynamic environments, and real-time sensor integration.

References

- Obstacle Avoidance Motion in Mobile Robotics – Yunchao Tang et al.
- Swarm Robotics: Cooperative Control in Multi-Agent Systems – Venkata Ramana Devi et al.
- Route planning of mobile robot using improved RRT* and TEB – XiongYin et al.