Pac-Mouse: An Autonomous Chase-and-Evade Simulation in Gazebo – TEAM ALPHA

Simulation (ROS 2 Jazzy Jalisco + Gazebo)

Main Objective:

This project aims to design and simulate an intelligent autonomous robot that can perceive, reason, and act within a maze environment inspired by the classic *Pac-Man* game. The system consists of two agents, a **mouse** (autonomous robot) and a **cat** (opponent). The mouse's objective is to explore the maze, collect all pieces of "cheese," and finally "eat" the cat, while the cat attempts to intercept or chase the mouse. The project demonstrates multi-agent interaction, autonomous navigation, and AI-based decision-making in a dynamic environment.

System Overview and AI Concepts:

The **mouse robot** will exhibit perception through multi-sensor fusion, reasoning through decision logic for exploration and evasion, and action via autonomous navigation and control. The maze will be procedurally generated (if feasible) or selected from four pre-defined layouts, each containing open loops and multiple paths to encourage adaptive behaviour.
The **cat robot** will initially act as an omniscient but non-optimal adversary (a "dumb pursuer"). If balancing becomes difficult, the cat may alternatively be human-controlled to maintain fair and demonstrable chase-and-evade interactions.

The project highlights AI principles of:

- **Perception:** Using sensor data (LiDAR, IMU, and camera) to sense the environment and identify objects.
- **Reasoning:** Determining optimal routes, avoiding capture, and deciding pursuit or evasion strategies.
- **Action:** Executing control commands for smooth navigation and object interaction within Gazebo.

Sensors / Inputs:

- **360° LiDAR** – for environmental mapping, obstacle detection, and navigation.
- **IMU (Inertial Measurement Unit)** – for orientation estimation and odometry correction.
- **RGB Camera(s)** – for colour-based object detection:
    - Yellow → Cheese
    - Red/White → Cat
    - Grey/Black → Walls

Expected Outputs / Behaviours:

- Autonomous maze exploration and mapping using LiDAR + IMU.
- Real-time colour detection to identify and track cheese and cat locations.
- Goal-directed navigation to collect all cheeses.
- Evasion and re-planning behaviour when the cat is detected nearby.
- Visualisation of sensor data, map, and decision-making process in Gazebo and RViz.
- Victory condition when all cheeses are collected and the cat is "defeated."