

The Adventures of ROSI the Turtlebot

Meet ROSI - Your New Robot Sidekick

Deep inside a digital realm called **Gazebo**, a small, round, and enthusiastic robot awakens for the first time. It blinks its single LiDAR eye, wiggles its differential-drive wheels, and announces proudly: **"Hello! My name is ROSI --- the Robotic Operative for Spatial Intelligence!"**

ROSI is in fact a **TurtleBot3 Burger**, the smallest of the TurtleBot family --- but also the bravest. It has no map, no GPS, no path planner, and zero idea where the walls are. But it has YOU --- its human mentor.

And it has a dream: **ROSI wants to learn how to navigate mazes all on its own.**

Not by being programmed step-by-step.
Not by following IF statements like a mindless toaster.
But by **learning**, like a real intelligent agent.

This is where your adventure begins...

ROSI's World

ROSI exists in a simulated environment built with ROS 2 and Gazebo Sim. You will place it in three different maze worlds:

1. **Maze 1 - "Baby Steps"** - Simple corridors, wide turns, and friendly layouts.
2. **Maze 2 - "The Middle School Maze"** - Grid-like complexity, dead ends, and a few tricky intersections.
3. **Maze 3 - "The Final Exam"** - Zig-zag passages, choke points, and cruel architectural decisions.

ROSI's only tools for survival are:

- **LiDAR**: 360° laser distance sensor telling it how close walls are
- **Odometry**: enables rough tracking of ROSI's movement
- **Your PPO brain**: a neural network you will implement

It does not get a map.

It does not get path planning.

It sees only floating point numbers and must decide how to move.

How ROSI Thinks

ROSI's brain is a **Proximal Policy Optimization (PPO)** neural network. It works by letting ROSI explore the world and make mistakes to learn a state-to-action policy that will lead it to successfully navigate to target position. So learning works in a loop. The loop works something like this:

- ROSI looks around (these are state):
 - LiDAR --> distances
 - Odometry --> position and orientation
- ROSI sends its observations to its brain:
 - A neural network predicts the best action.
- ROSI moves. It sets (these are actions):
 - linear velocity (forward)
 - angular velocity (turn left/right)
- It receives a reward, e.g.:
 - +1 if it reaches the goal
 - -1 if it crashes
 - small positive if it moves toward the goal
 - small negative if it wastes time
- Its brain updates:
 - PPO adjusts weights to maximize long-term reward

Over time, ROSI evolves from “**AAAA where am I?**” to “**I understand corridors now.**”

How ROSI Sees the World

ROSI's perception can be represented as a simple float vector:

```
[  
    lidar_value_1, lidar_value_2, ...,  
    odometry position values,  
    odometry orientation values,  
    current linear and angular velocities  
]
```

This is what feeds its neural network every timestep. It also knows the navigation goal (target) position at each moment (try to use this information :))!

Your Tasks (a rough proposal)

To help ROSI learn, **you must build and tune its intelligence**:

1. **Implement the Observation Vector.** Convert ROSI's raw perception data into a usable neural network input.
2. **Create ROSI's Reward Function.** You design its motivation system, e.g.:
 1. Bigger reward for reaching or coming closer to goals
 2. Penalty for collision
 3. Shaping rewards for navigational progress
3. **Implement Collision & Success Checks.** ROSI needs to know when
 1. It reached the goal
 2. It hit a wall
 3. It ran out of time
4. **Train ROSI with PPO**
 1. Run training sessions.
 2. Let it fail.
 3. Let it improve.
 4. Let it become a maze master.
5. **Evaluate ROSI**
 1. Test ROSI in multiple mazes.
 2. Record success rate, collisions, path length.
6. **Submit and Present Your Work.** You submit:
 1. Final code including your trained PPO model
 2. Report about ROSI's learning journey
 3. Final presentation slides

What you receive:

You will get:

- **lr_turtlebot_sim/** ROS2 package - launch ROSI with Gazebo inside any maze

You must create:

- **lr_ppo/ ROS2** package - the PPO training platform that uses lr_turtlebot_sim.

Final Words

ROSI is not just a robot.

It is your student.

Your experiment.

Your little AI explorer.

By the end of this project, you will have:

- trained a reinforcement-learning robot,
- integrated ROS2 + Gazebo + PPO,
- designed real robot intelligence,
- and watched ROSI learn from scratch.

Now go teach ROSI how to conquer the maze!