

Chapter 9 — Navigation (AMCL + Costmaps)

[DIAGRAM — NAVIGATION FLOW]

Map Server → AMCL Localization → Costmaps → Global Planner → TEB Local Planner → /cmd_vel
→ Robot Motion

1. Overview

Navigation allows the robot to move to a goal on a saved map. It uses AMCL for localization and costmaps for obstacle awareness.

2. Start Navigation System

Run bringup:

```
roslaunch r2_bringup minimal.launch
```

Load your map:

```
roslaunch r2_navigation map_load.launch map_file:=mymap.yaml
```

Start navigation:

```
roslaunch r2_navigation navigation.launch
```

3. AMCL (Localization)

AMCL uses LiDAR to estimate where the robot is on the map.

- Keeps robot aligned with walls
- Updates position as robot moves
- Critical for accurate navigation

4. Costmaps Explained

Global costmap: full map obstacle layer for long distance planning.

Local costmap: short range planning around robot.

Inflation: safety 'bubble' around obstacles.

5. Sending a Navigation Goal

In RViz:

- Click '2D Nav Goal'
- Click on the map

Robot drives toward the arrow you place.

6. Smooth Navigation Tips

- Keep speed low (0.15 m/s).
- Avoid sudden joystick overrides.
- Ensure LiDAR has clear view.

7. Recovery Behaviors

If robot gets stuck:

- Rotate in place
- Backup
- Replan path

These are automatic.

8. When Navigation Fails

- Map not loaded
- AMCL cannot localize
- LiDAR blocked
- No valid path
- Costmaps not updating

9. Safety Notes

- Clear all obstacles.
- Watch robot during moves.
- Keep pets/people away.
- Stop immediately if robot drifts.