PDDL planning for an autonomous dumper

Objective

Design and implement a concise PDDL task planner and execution layer that coordinates the **Load**, **Navigate,** and **Download** functions from an autonomous dumper; evaluate task success, robustness, and dump distribution.

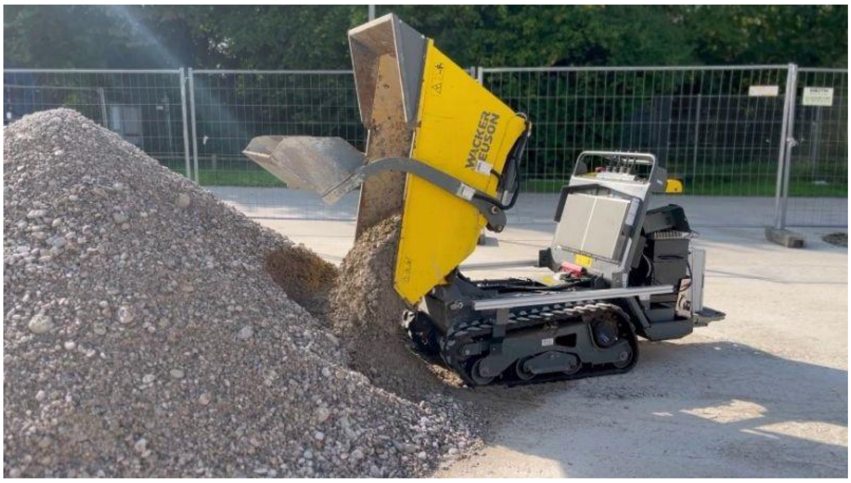

Figure 1: Autonomous Construction Robot

Background & motivation

PDDL planners provide a structured way to coordinate complex robot behaviors by reasoning over goals and available actions instead of hardcoding sequences. This allows the robot to flexibly adapt when tasks or environments change, automatically generating action plans that combine perception, navigation, and manipulation. Unlike purely procedural control, PDDL enables high-level decision-making, easier integration of new behaviors, and robust recovery from failures, making it well-suited for autonomous robots operating in dynamic and uncertain settings.

Scope & assumptions

The PDDL planner should coordinate the different functionalities required for automating material flow operations with the autonomous dumper:

1. **Unload** function (already implemented with a behavior tree)
2. **Navigate** function (under implementation on Nav2, but might require refinement)
3. **Download** function (to be developed using a behavior tree).

Core contributions

1. A compact PDDL domain that coordinates the dumper tasks (Load, Navigate, Download).
2. RViz-based user interface to define the load and download areas and the Transport Material command.
    - The user should define the upload and download areas using polygons in RViz.
    - Then, the user should press the “Execute” button to start the material transport functionality.
3. Implementation and evaluation of the Download function as a behavior tree where the robot should download the skip at a given region:
    - If a point is given, the dumper downloads the whole material to this point.
    - If a region is given, the robot should download the material while navigating backwards to distribute the material throughout the entire area.
4. Extra points are given if the local map from the construction area can be extracted from Google Maps and integrated into RViz.

Requirements

- ROS2 & Behavior Trees – Experience with ROS2 (especially Nav2) and behavior tree frameworks for implementing robot actions.
- 3D Visualization & Interfaces – Ability to develop RViz-based user interfaces for task definition and execution.
- Robot Navigation & Control – Understanding of autonomous navigation and material handling tasks in robotics.
- Integration & Evaluation – Skills in integrating multiple modules (planning, navigation, perception) and evaluating system performance in real scenarios.
- Task Planning & PDDL (Desired but not mandatory)– Knowledge of Planning Domain Definition Language (PDDL) for modeling robot tasks and high-level decision-making.