

Control of Mobile Robots
Extended project work
Analysing DWA control technique, and comparing it with the tools presented in the lectures
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Problem

Consider DWA, one of the local planners available in ROS navigation package `move_base`.

Analyse the Dynamic Window Approach algorithm presented in:

D. Fox, W. Burgard and S. Thrun, "The dynamic window approach to collision avoidance," in *IEEE Robotics & Automation Magazine*, vol. 4, no. 1, pp. 23-33, March 1997

and compare it with its ROS implementation `dwa_local_planner` (e.g., is the implemented version identical to the one described in the paper? otherwise, what are the main differences?).

Design a simple case study to compare the behaviour of a robot controlled with DWA and of one controlled with a trajectory tracking control law presented in the course. In particular, you can consider:

- a unicycle, a differential drive, or a bicycle robot;
- a trajectory tracking controller composed of an inner linearisation law, based on the kinematic model, and an outer tracking law, based on a proportional integral controller with velocity feed-forward (CMR-controller);
- a desired trajectory analytically defined or represented as a sequence of (x, y) points;

and perform the following activities:

- set up the software to simulate the robot, using its kinematic model, and to implement the controller (if it is possible, use a software architecture as simple as possible, and use the same simulator for DWA and CMR-controller);
- define reasonable requirements for the trajectory tracking controller and tune CMR-controller accordingly;
- tune DWA to exhibit the same performance of CMR-controller.

The project should aim at preparing educational material for a student with limited experience in using ROS and coding in C++, attending the course Control of mobile robots. You can thus assume that the student has all the required competences on kinematic/dynamic modelling and control of mobile robots, and he/she is interested in increasing his/her ROS knowledge and in exploiting ROS tools to verify the competences acquired during lectures. In preparing this material, please consider also the following topics:

- how to explain, using the tools presented in the course DWA approach, drawing parallels, if it is possible, between the two control techniques;
- how to set up the simplest ROS environment allowing to support a comparison between the two control systems, i.e., able to emphasise pros and cons of the two approaches;
- how to tune DWA starting from a set of requirements and following, if it is possible, a rational procedure.

As a result of the project work you should prepare:

- a presentation of the work (it has to be prepared as it should be the presentation a teacher uses to introduce this laboratorial activity to students);
- a report describing the results of the work, including a short user manual explaining how to use the code (again, this report should be intended as a support for a student who would like to replicate the laboratory experience);
- well-organised and well-documented code.