DWA vs custom trajectory tracking controller

A comparison in ROS

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Academic Year 2022/2023

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Frame title

In this slide, some important text will be highlighted because it's important. Please, don't abuse it.

Remark

Sample text

Important theorem

Sample text in red box

Examples

Sample text in green box. The title of the block is "Examples".

Frame title

This is a text in first column.

$$E = mc^2$$

- First item
- Second item

This text will be in the second column and on a second thoughts, this is a nice looking layout in some cases.

Project overview

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Differential drive

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Paper formulation

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ROS implementation

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Unicycle model control

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Controller's architecture

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Experiment setup - the robot

The robot:

- differential drive
- $\mathtt{d} = 15$ cm (wheels distance)
- $\mathtt{r} = 3$ cm (wheels radius)
- pentagonal footprint

[IMAGE FROM RVIZ]

Experiment setup - the map

The map:

- empty, no obstacles around
- global, no need for a local one

[IMAGE FROM RVIZ]

Experiment setup - the trajectory

The trajectory:

- eight-shaped
- 2 x 1 meters
- discretized into multiple goals

[IMAGE FROM RVIZ]

ROS architecture - overview

Three packages:

- `diffdrive_kin_sim` → simulator
- `diffdrive_kin_ctrl` → custom controller
- `diffdrive_dwa_ctrl` → DWA controller

The two controllers are interchangeable and are meant to always be used together with the simulator, one at a time.

ROS architecture - service & frames

One service:

- `generate_desired_path_service` → used to generate the eight-shaped trajectory as soon as it is invoked by one of the two controllers

Three fames:

- `map` → for the empty map provided by the map server
- `odom` → representing the global reference system
- `base_link` → representing the moving reference system

ROS architecture - nodes

Four nodes:

- `diffdrive_kin_sim_node`, $\rightarrow$ integration logic to update the robot pose given (ω_r,ω_l)
- `diffdrive_kin_trajctrl_node`, $\rightarrow$ computation of (ω_r,ω_l) to reach the next point in the trajectory, using the custom controller
- `diffdrive_dwa_trajctrl_node`, $\rightarrow$ interface between DWA library and simulator to compute (ω_r,ω_l)
- `odom_to_baselink_tf_node`, link between the `odom` and the `base_link` coordinate frames through a dynamic tf

ROS architecture - topics

Four nodes:

- `/clock`, $\rightarrow$ synchronization of all the nodes in the simulation
- `/odom`, $\rightarrow$ communication of the odometry information of the robot to DWA
- `/robot_state`, $\rightarrow$ communication of the odometry information of the robot to the custom controller
- `/controller_state`, $\rightarrow$ for visualization purposes
- `/robot_input`, $\rightarrow$ communication of (ω_r,ω_l) computed by the controllers

ROS architecture - launch files

Two launch files:

- `diffdrive_kin_trajctrl.launch` → start the simulation of the robot's behavior with the custom controller
- `diffdrive_dwa_trajctrl.launch` → start the simulation of the robot's behavior with DWA

Parameters tuning - trajectory

$$\begin{cases} x = \mathtt{a} \cdot \sin(\mathtt{w} \cdot t) \\ y = \mathtt{a} \cdot \sin(\mathtt{w} \cdot t) \cdot \cos(\mathtt{w} \cdot t) \end{cases}$$

Two main parameters:

- $\mathtt{a} \rightarrow$ amplitude of the eight-shaped trajectory
- $\mathtt{w} \rightarrow$ ratio $\frac{2 \cdot \pi}{T}$ where T is the time duration of each lap

Assigned values

$$\mathtt{a} = 1 \qquad \mathtt{w} = 1$$

Parameters tuning - custom controller

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau)\,d\tau + K_d \frac{de(t)}{dt}$$

Three main parameters:

- $K_p \rightarrow$ proportional gain of the PID controller
- $K_i \rightarrow$ integral gain of the PID controller
- $K_d \rightarrow$ derivative gain of the PID controller

Assigned values

$K_p = 0.8$ $K_i = 0.8$ $K_d = 0.0$

Parameters tuning - DWA

One main parameter:

- `skipped_goals` $\rightarrow$ number of points to skip when feeding the trajectory to DWA

Assigned values

$$\texttt{skipped\_goals} = 1$$

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Trajectory tracking controller

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DWA

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Deprecated parameters

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DWA used standalone

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Multiple goals

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