MAD76 Academy: C. Car Race

Frank Tränkle*
Hochschule Heilbronn, Germany

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*frank.traenkle@hs-heilbronn.de

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1 Start and Run

1.1 Driverless Race

- After installation, remote control calibration, and computer vision configuration, you are now ready to race.
- In this race, up to four cars run autonomously.
- Optionally, one human player can assume manual control of the orange/red car 0 and compete against the driverless cars.
- The lap statistics of car 0 are recorded and displayed in a web browser.
- For starting the race on the real MAD76 track, open a terminal on the Raspberry Pi 5 and run:

```
ros2 launch mbmad madpislfull.launch
```

- Alternatively, if you have installed MAD76 on a PC, you may start the race in simulation mode by running:

```
ros2 launch mbmad madpislsim.launch
```

- Note: Never start `madpislfull.launch` or `madpislsim.launch` at the same time or more than once without stopping the previous instance first.
- Open a new terminal, and start all cars by running:

```
ros2 run mbmadcar send_maneuver.py
```

- The driverless cars will race against each other.
- Whereas car id 0 (orange/red) is controlled by PI and state-space controllers, known from Bachelor-degree programs,
- all other cars with ids 1 ot 3 are controlled by AI agents (reinforcement learning Software-Actor-Critic agents, SAC agents).

1.2 Adapt Behavior of Car Id 0

- The behavior of car id 0 can be adapted by individual sending maneuver messages.
- Stop `send_maneuver.py` from above by hitting `Ctrl+C`.
- All cars keep on running autonomously.
- Send maneuver to car 0 (orange/red car)

```
ros2 run mbmadcar send_maneuver.py 0 0.3 0.25
```

  - First argument is the car identifier
  - Second argument is the car reference speed in $\frac{\mathrm{m}}{\mathrm{s}}$
  - Third argument is the lateral reference position

0	right curb
0.25	right lane
0.5	center line
0.75	left lane
1	left curb
-1	ideal line for low laptimes

- The maximum speed of each car is $0.5\frac{\mathrm{m}}{\mathrm{s}}$

- You may stop the individual car by sending a maneuver with reference speed $0\frac{\mathrm{m}}{\mathrm{s}}$
- Reverse driving is possible by setting a negative reference speed

1.3 Human Player

- One human player may assume manual control of car 0 by powering up the Xbox controller.
- Car 0 now stops automatically and waits for manual control.
- The left vertical joystick control is for thrust, braking, and reversing.
- The right horizontal joystick controls steering.
- In slow driving, MAD76 supports the human player by stabilizing the car in the lane.
- You may pass the control of car 0 back to autonomous driving by switching off the Xbox controller.
- For lap statistics and ranking, open a web browser on the Raspberry Pi 5 and navigate to `http://localhost:8082`.
  - Enter a driver name and hit `Start`
  - Then the lap times and average lap speed are measured and displayed
  - Lap times of drivers are ranked in a leaderboard

1.4 Measuring Vehicle Dynamics States

- With `rqt_plot` of ROS2, message signals can be measured and plotted in oscilloscopes
- Open a new terminal and run:

```
ros2 run rqt_plot rqt_plot
```

- In the opened window, enter the topic name plus signal element name in the entry field and hit the button +
- E.g. enter `/mad/locate/carobs/list[0]/v` to plot the speed of car 0