4. Assignment, Introduction to Robotics WS16/17

Prof. Daniel Göhring, Zahra Boroujeni
Institut für Informatik, Freie Universität Berlin
Submission: online until Sunday, 04. Dec 2016, 11:55 p.m.

Please summarize your results (images and descriptions) in a pdf-document and name it "RO-04-<surnames of the students - group name>.pdf". There should not be any source code in the pdf document.
By the end of this class you will need 50% of points to be allowed to write the final exam.

1. Denavit Hartenberg Notation (2 Points):

a) (0.5 Point) Annotate missing axes of the coordinate frames, e.g., x_1, y_1, z_1, …
b) (1 Point) Fill the missing values, denoted by "?" in the table below with values according to the Denavit Hartenberg notation.
c) (0.5 Point) Please provide the transformation matrix which maps vectors represented in coordinate frame {3} into coordinate frame {2} .

Robotics 2016/17

i	a_{i-1}	α_{i-1}	d_i	θ_i
1	?	?	?	?
2	?	?	?	?
3	?	?	?	?

Config. shown: $\theta_1 = ?, \theta_2 = ?, \theta_3 = ?$
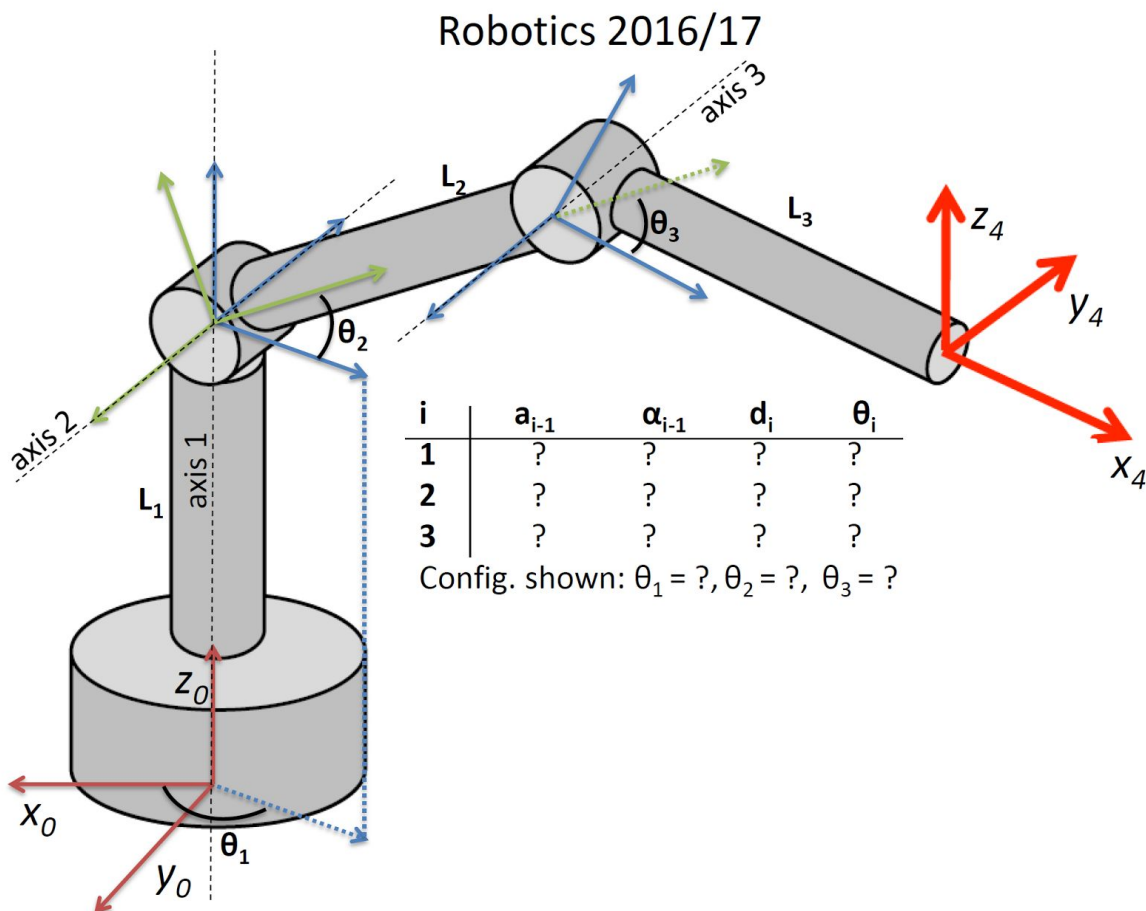
Preliminary: Schedule up to 2 hours for your group with the car - all three group members have to fill the doodle:

Remove the obstacles around the car. NEVER stop the auto_stop node, it is for the safety of you and the car!

2. A circle trajectory: (2 Points):

Place the car on a box with the wheels in the air at first.

- Publish once -500 rpm as the desired speed of motor (topic name: `/manual_control/speed`).
- Publish once maximum steering angle to turn to left. (90 or -90) (topic name: `/manual_control/steering std_msgs/Int16`)
- Run the heading Node: `roslaunch heading heading_odroid.launch`
- Write a program which subscribes to the head angle of the car (topic name: `/model_car/yaw`)
- In your program, stop the car when the car finishes a circle. (reached the same head angle at the beginning.)
- Now, test if the car stops for obstacles. Then, if it does, let the car move on the ground in a circle.
- Draw the head angle vs time. Calculate the time duration.

3- Calculate odometry [x,y,theta] (5 Points)

- Find the ratio between motor (rpm) and position of the car in a straight line. Design a test.
  For example: Place the car on the ground, send the command -200 rpm to the motor, after 2 seconds, stop the car. Using rqt_plot, find the area under the curve of motor_control/twist/linear/x. Measure the displacement of the car. Calculate the ratio.
  ratio = displacement of the car*60/ area

  Hint: Ratio depends on the gearbox between the motor and the wheel, wheel diameter.

- Write a program to subscribe to the topic `motor_control`/`twist`/`linear`/`x` as speed of the car and `/model_car/yaw` as the head angle of the car. Calculate the position of the car using the ratio that you found in previous step.

Hint: The code below would help you a lot:

https://github.com/AutoModelCar/model_car/blob/master/catkin_ws/src/odometry/src/odometry_publisher.cpp

4- Test the odometry (1 Point):

Test the odometry calculation as in task 2) of this assignment, you should reach the origin position after a circle, Plot x, y and theta vs time.