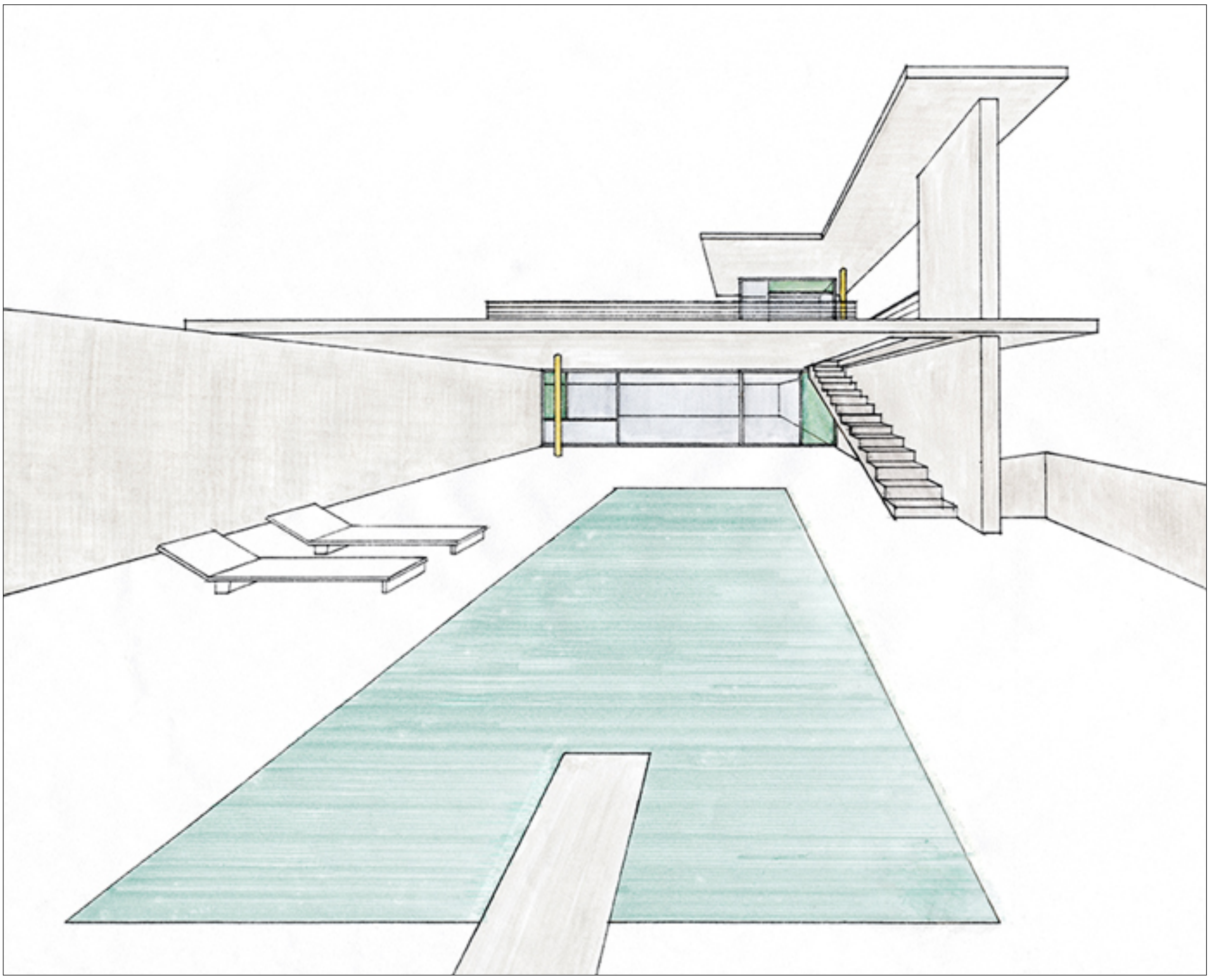

Assignment 2

Wheeled Mobile Robot (Differential Drive) Control

Artificial Intelligence for Robotics
Dr. Min-Fan Ricky Lee

Wheeled Mobile Robot (Differential Drive) Control

1 Create your own code

1.1 Feed Forward Control

For a differential-drive robot, Give initial pose ($\boldsymbol{x}$, $\boldsymbol{y}$, $\boldsymbol{\theta}$)=(3, 5, $\pi/4$), $\boldsymbol{r}$=1 and $\boldsymbol{L}$=2 with initial ω_R= 0, ω_L = 0, angular velocity profile of wheel in Figure 1 and sampling time 0.01, where following relation sustained with $\boldsymbol{R}$=15 and $\omega_{L,\,max}$ = 100

$$\frac{\omega_R}{\omega_L} = \frac{2R - L}{2R + L}$$

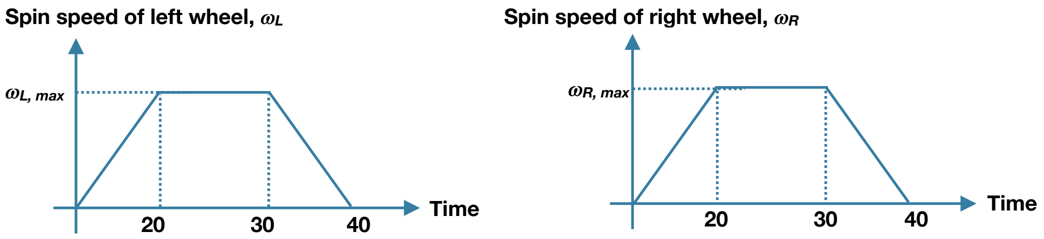

Figure 1. angular velocity profile of wheel

Use the Model in **"1. Forward Kinematic Model"**[1, pp. 2-9] to generate a trajectory (Plot in *x* and *y* axis of world frame) from initial pose and show the final pose ($\boldsymbol{x}$, $\boldsymbol{y}$, $\boldsymbol{\theta}$) in plot as well.

Submission

1. Matlab Code: File name as ***ForwardKinematic.mlx***
2. Report (IEEE Paper Format)

1.2 Circular Motion

Make the robot to move a circular motion as shown in Figure 2 (rotate an angle of φ = 120˚ with radius of $\boldsymbol{R}$= 100 cm) by design an angular velocity profile for the right and left wheels respectively as shown in Figure 3.

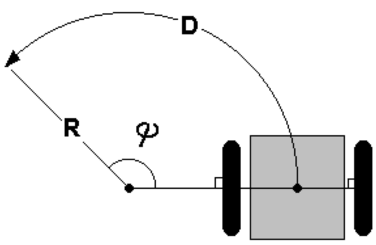

Figure 2. Circular motion

Wheeled Mobile Robot (Differential Drive) Control

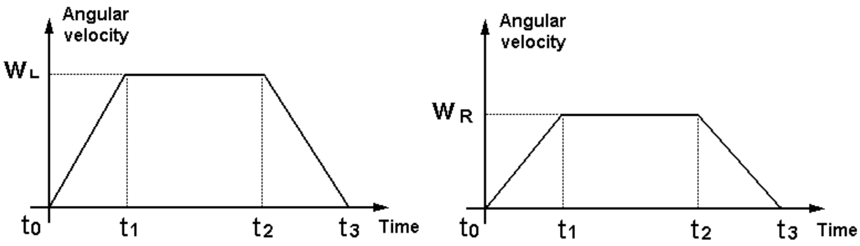

Figure 3. angular velocity profile for the right and left wheel

Use Model in**"2. Circular Motion"**[1, pp. 10-17] to generate a trajectory (Plot in *x* and *y* axis of world frame) from initial pose and show the final pose (***x***, ***y***, ***θ***) in plot as well.

Submission

1. Matlab Code: File name as ***CircularMotion.mlx***
2. Report (IEEE Paper Format)

1.3 Close-loop control

For a precise and smooth movement of robot, a linear control law was proposed. The main formulas are summarized below:

$$v = k_\rho \rho$$

$$\omega = k_\alpha \alpha + k_\beta \beta$$

Apply strong stability condition

$$k_\rho > 0; k_\beta < 0; k_\alpha + \frac{5}{3}k_\beta - \frac{2}{\pi}k_\rho > 0$$

Use Model in**"3. Close-Loop Control"**[1, pp. 18-28] as shown in Figure 4 to implement and test the controller for 8 different poses (positions and orientations) as shown in Figure 5.

Submission

1. Matlab Code: File name as ***CloseLoopControl.mlx***
2. Report (IEEE Paper Format)

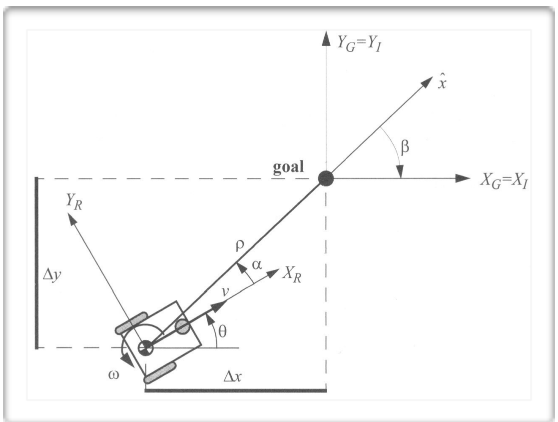

Figure 4. Problem statement for closed-loop motion control

Wheeled Mobile Robot (Differential Drive) Control

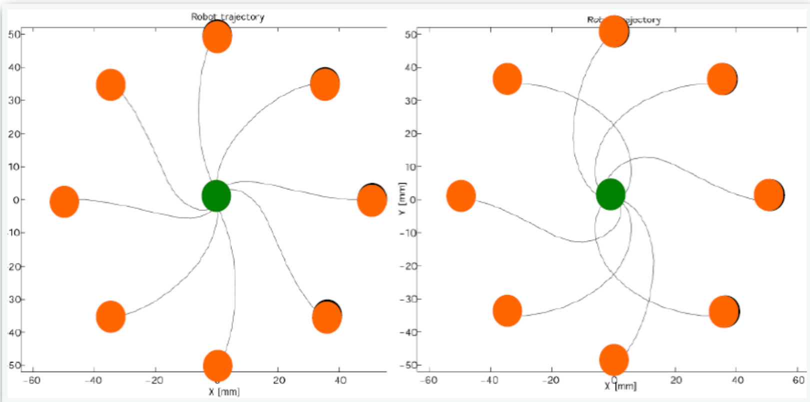

Figure 5. Test scenarios for close loop control

2 Robotic Toolbox

2.1 Moving to pose

Download Robotics Toolbox http://petercorke.com/wordpress/toolboxes/robotics-toolbox and ***MobileRobot.mlx*** in Moodle.

Use Simulink Model (***sl_drivepose***) in **"1. Car-Like Mobile Robots.Moving to a Pose"[2, pp. 62-73]** and ***MobileRobot.mlx*** in Code to verify and compare with result from **1.3 Close-loop control**.

Submission

1. Matlab Code: File name as ***MovingToPose.mlx***
2. Report (IEEE Paper Format)

References

1. Min-Fan Ricky Lee,"Assignment 2 Slide, " 2020
2. Min-Fan Ricky Lee,"*Mobile Robot I*," Lecture 2 Slide, 2020