Chalmers Tekniska Högskola

CHALMERS
UNIVERSITY OF TECHNOLOGY

Autonomous Robots

Assignment 2

Submitted by:
Himanshu Sahni

1 Part A

Given:

$$v_L(t) = \frac{v_0}{t_1} t$$

$$v_R(t) = \frac{v_0}{t_2} t$$

The initial conditions of the system:

$$t_0 = 0\,, \quad x_0 = 0\,, \quad y_0 = 0\,, \quad \phi_0 = 0$$

Formulas from the lecture:

$$v = \frac{v_R + v_L}{2}$$

$$\dot{\varphi} = \frac{v_R - v_L}{2R}$$

$$v_x = v\cos(\varphi)$$

$$v_y = v\sin(\varphi)$$

$$\begin{aligned} x(t) &= x_0 + \int_{t_0}^{t} \frac{v_L(t') + v_R(t')}{2}\, cos(\phi(t'))\, dt' \\ y(t) &= y_0 + \int_{t_0}^{t} \frac{v_L(t') + v_R(t')}{2}\, sin(\phi(t'))\, dt' \\ \phi(t) &= \phi_0 + \int_{t_0}^{t} \frac{v_R(t') - v_L(t')}{2R}\, dt' \end{aligned}$$

Substituting the equations for the equations of motion with initial conditions:

$$\phi(t) = \frac{v_0}{2R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)\int_0^t t'\, dt' = \frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t^2$$

$$x(t) = \frac{v_0}{2}\left(\frac{1}{t_1} + \frac{1}{t_2}\right)\int_0^t t'\, cos(\phi(t'))\, dt'$$

$$= R\left(\frac{1}{t_2} - \frac{1}{t_1}\right)^{-1}\left(\frac{1}{t_1} + \frac{1}{t_2}\right)\int_0^t \frac{v_0}{2R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t'\, cos\left[\frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t'^2\right] dt'$$

$$= R\left(\frac{1}{t_2} - \frac{1}{t_1}\right)^{-1}\left(\frac{1}{t_1} + \frac{1}{t_2}\right) sin\left[\frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t^2\right]$$

$$y(t) = \frac{v_0}{2}\left(\frac{1}{t_1} + \frac{1}{t_2}\right)\int_0^t t'\, sin(\phi(t'))\, dt'$$

$$= R\left(\frac{1}{t_2} - \frac{1}{t_1}\right)^{-1}\left(\frac{1}{t_1} + \frac{1}{t_2}\right)\int_0^t \frac{v_0}{2R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t'\, sin\left[\frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t'^2\right] dt'$$

$$= R\left(\frac{1}{t_2} - \frac{1}{t_1}\right)^{-1}\left(\frac{1}{t_1} + \frac{1}{t_2}\right)\left[1 + cos\left[\frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t^2\right]\right]$$

The equations of Motion are:

$$x(t) = R\left(\frac{1}{t_2} - \frac{1}{t_1}\right)^{-1}\left(\frac{1}{t_1} + \frac{1}{t_2}\right) sin\left[\frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t^2\right] \tag{1}$$

$$y(t) = R\left(\frac{1}{t_2} - \frac{1}{t_1}\right)^{-1}\left(\frac{1}{t_1} + \frac{1}{t_2}\right)\left[1 + cos\left[\frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t^2\right]\right] \tag{2}$$

$$\phi(t) = \frac{v_0}{4R}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)t^2 \tag{3}$$

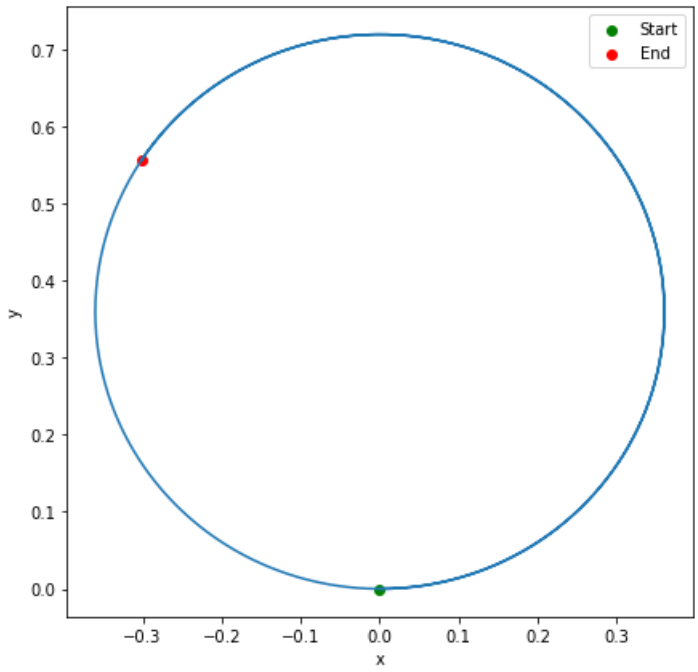

Figure 1: **Trajectory**

The plot of the x and y coordinates for t = [0, 10]:

Note: The part a folder contains the python code for the trajectory plot and an image of the plot.

2 Part B

The partb folder contains two folders: 1. opendlv-logic-test-kiwi 2. opendlv-virtual-motor-kiwi

The opendlv-logic-test-kiwi has all the code for the behavior and the opendlv-virtual-motor-kiwi has all the code for the kinematics. Also, I have added the files of kiwi-simulations in the opendlv-logic-test-kiwi folder.

To run the program:

1. You can open two separate terminals, one with the folder pointing to opendlv-logic-test-kiwi and the other pointing to opendlv-virtual-motor-kiwi.

2. Then for the opendlv-logic-test-kiwi, build the logic with the command: docker build -t registry.opendlv.org/community/opendlv-logic-test-kiwi:1.1 .

3. and for the opendlv-virtual-motor-kiwi, Build the kinematics with the command: docker build -t registry.opendlv.org/community/opendlv-virtual-motor-kiwi:1.0 .

4. Then after building both, run the virtual environment and the simulation with opendlv-virtual-space using a web browser and point it to http://localhost:8081

Note: The partb folder contains a rec file of the simulation. Also, I wanted to inform you that in my case I don't get the exact values i.e., (0.2, -0.4). I have tried a lot to achieve this but I could not get it. It would be great if you can tell me where I am going wrong.

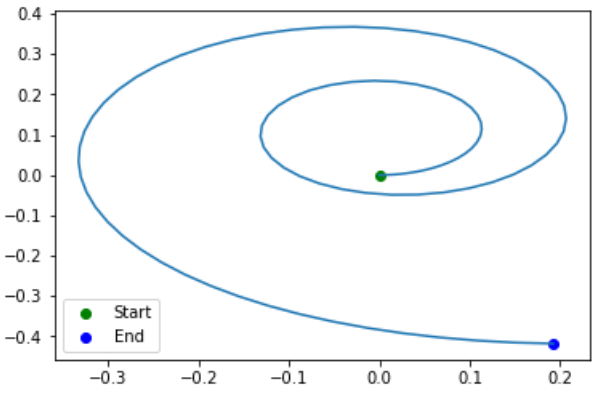

Figure 2: **Trajectory**