Implement via software the unicycle posture regulator based on polar coordinates, with the state feedback computed through the Runge-Kutta odometric localization method. Starting and final configurations are as in the previous exercise.

The robot must be brought from q_i =[x_i y_i θ_i]=[5 2 $\frac{\pi}{2}$] to the origin.

The localization is the procedure of estimating the robot's state. The Runge-Kutta odometric localization method takes in input from the unicycle the constant heading velocity v_k and angular velocity ω_k in a time interval [t_k, t_k+T_s], where the sampling time Ts has been chosen equal to 0.01 and gives back the value

q(t_{k+1})= q_{k+1} through these equations

$$\begin{cases} x_{k+1} = x_k + v_k T_s \cos\left(\theta_k + \frac{1}{2}\omega_k T_s\right) \\ y_{k+1} = y_k + v_k T_s \sin\left(\theta_k + \frac{1}{2}\omega_k T_s\right) \\ \theta_{k+1} = \theta_k + \omega_k T_s \end{cases}$$

To express the problem in polar coordinates:

$$\rho = \sqrt{x^2 + y^2}$$
$$\gamma = atan2(y, x) - \theta + \pi$$
$$\delta = \gamma + \theta$$

Where:

- ρ=|e_p| is the distance between the unicycle and the origin
- γ is the angle between e_p and the sagittal axis
- $\delta$is the angle between e_p and the x –axis

We design the following controllers

$$v = k_1 \rho \cos\gamma$$
$$\omega = k_2\gamma + k_1 \sin\gamma\cos\gamma\left(1 + k_3\frac{\delta}{\gamma}\right)$$

- $k_1, k_2, k_3 > 0$

The value chosen are $k_1 = 2, k_2 = 7, k_3 = 1$

The implementation is present in the file HW2_5.slx, the results are:

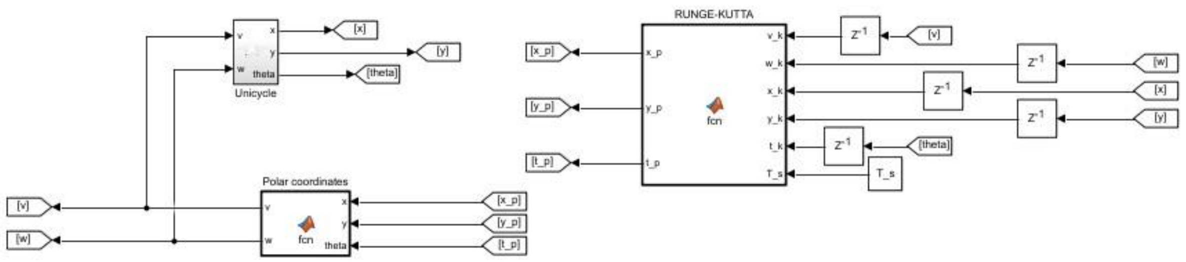

Figure 1:scheme of the fifth exercise

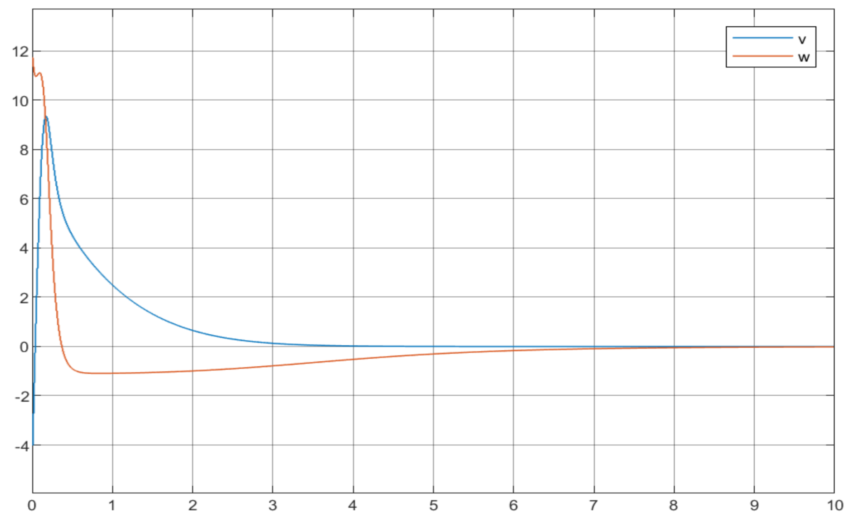

Figure 2:heading and angular velocity

the v starts from a negative value, this means that it moves backwards, while the w takes on a value approximately equal to 12.

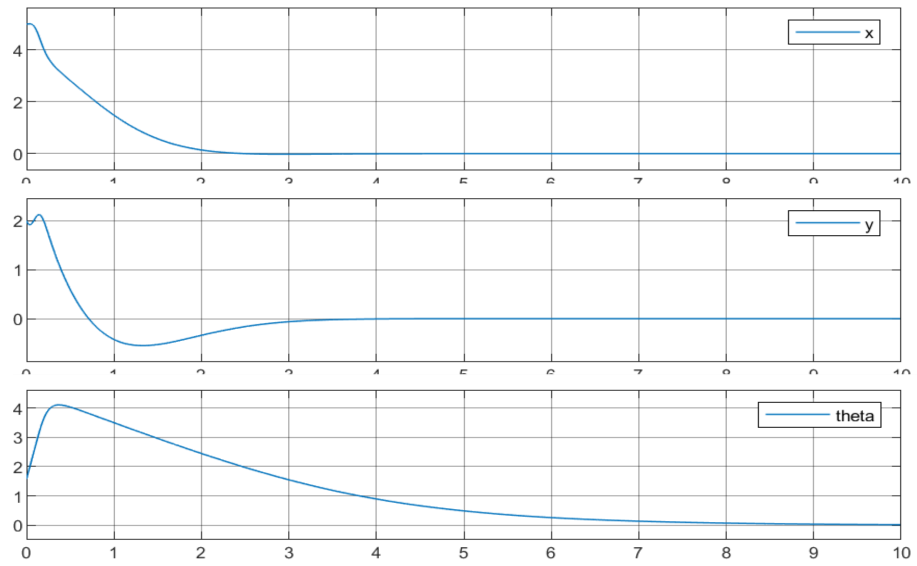

Figure 3:x y theta of the unicycle

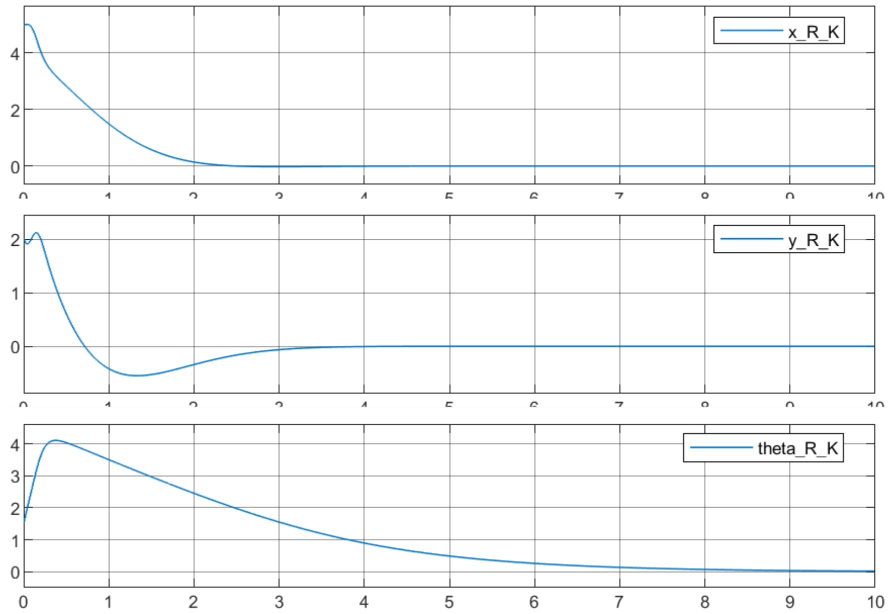

Figure 4:x y theta in output from the RUNGE-KUTTA

Signals x, y and θ tend to 0 asymptotically.