

# Model Predictive Control - EL2700

KTH ROYAL INSTITUTE OF TECHNOLOGY

Assignment 2: Finite Time Optimal Control

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## Question 1

Completed in the relevant .py files attached.

## Question 2

Completed in the relevant .py files attached.

## Question 3

Completed in the relevant .py files attached.

## Question 4

Following the simulation of the system, we have plots over time to visualize the state error, the prediction against the reference and the state against the reference. These are shown below.

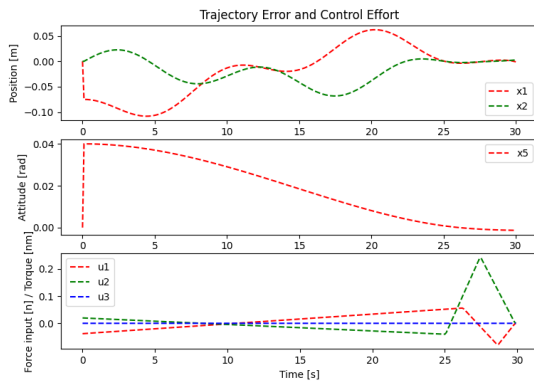


Figure 1: State Error

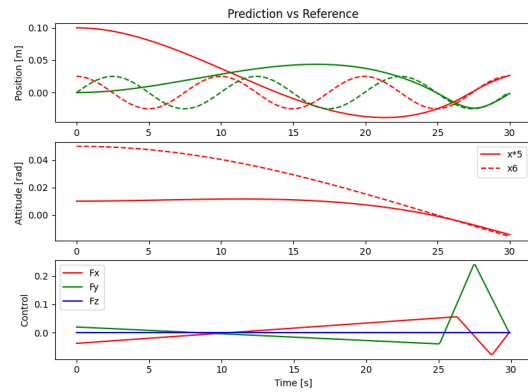


Figure 2: Prediction vs Reference

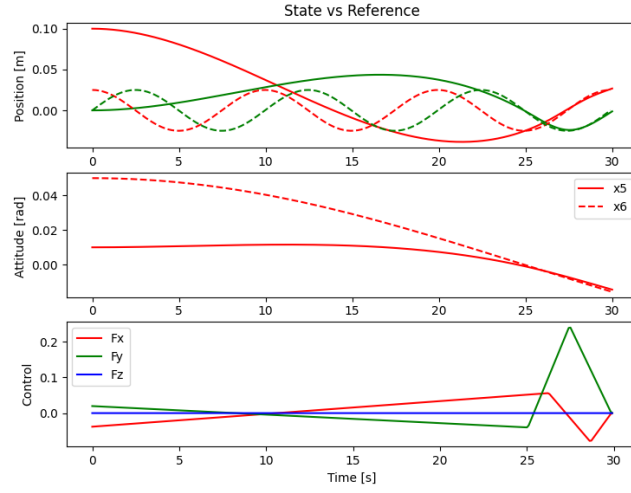


Figure 3: State vs Reference

## Question 5

Following the malfunction of one of the thrusters, the below state error plot resulted.

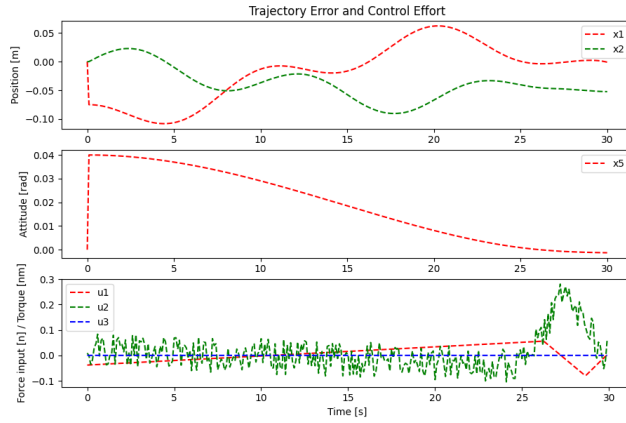


Figure 4: State vs Reference

When feeding the system with the previously generated control inputs we see that the error of state  $x_2$  does not converge to zero. Since our model assumes that state  $x_2$  is solely dependent on control input 2 ( $f_y$  the force along the  $y$  axis), erratic thrust outputs of the

thruster would naturally lead to an error of state  $x_2$ .

## Question 6

Since our current model assumes a decoupled system we could attempt to make our model more realistic by developing a new model in which the states are coupled. As such we would have a degree of control state  $x_1$  and  $x_2$  using a single thruster. The alternative approach would be to fix the thruster (not very insightful).

## Question 7

Extending our model by adding translation on the Z axis and running the simulation resulted in the following plot. Considering the time-to-solution of the 2D and 3D simulations, we can conclude that adding more dimensions significantly decreases the performance. This is emphasized by the respective time-to-solution for the 2D and 3D cases, which were approximately 0.1156s and 0.8106s respectively.

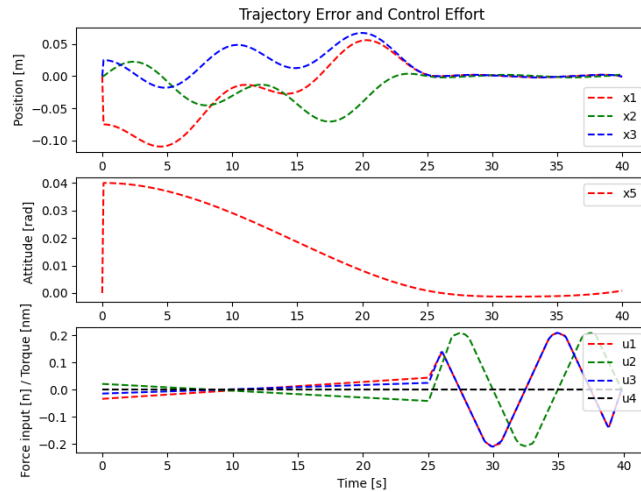


Figure 5: State vs Reference