LQR

“some theory”

For the matrices Q and R to set for the LQR implementation, we’ve chosen the parameter such that the states would reach 0 as soon as possible and the Control system wouldn’t use too much control variable: the q >> r

Control at the Unstable Position

After some trials, changing the parameters q and r, with the real model, we’ve found the proper matrices:

[qθ=10 qθ\_dot=1 qϕ=10 qϕ\_dot=10] and [r=1] “fix this visualization lol”

The qs related to the states of the bar should be higher if we want them to reach the equilibrium quickly (ϕ=180° and ϕ\_dot=0), instead the qs related to the states of the rod can be lower like q=1 and tis means they can move due to a perturbation and return to the equilibrium point slower than the bar, the important thing is that the bar is kept upside. What we notice when fixing the parameters is that the rod is not reaching the equilibrium point (at 0° position), maybe because while trying it the bar is not that steady, so the rod tries to reach new static position everytime and as a result the rod is not steady. To solve this solution we set the value for θ the same as for ϕ the .

For the Control Variable we initially set it to a very low value, r=0.01, since we wanted the qs much higher as we wanted the state to reach the equilibrium faster rather than penalizing the control variable. This, tho, causes the Control variable to be agressive (fast and high variation of the Voltage input), the response to a disturbance was very good tho, very fast to keep the bar at the vertical position. The problem was that the rod wasn’t steady, it was keeping to move either one side o the otherside depending on the perturbation on the bar. So as final value we choose for the Control variable is r=1.

In this phase of finding the proper values for the matrices we observed that:

* higher value for the qs causes a strong action, to solve this a higher value for r is needed
* the couple qs for each angle should not be that so differenti, even intuitively
* if you want the rod to not randomly walk and also hit the end stop, you should choose the same value as for the bar pendulum

As result we obtain the following verctor containing the gains: [-3.1623 -1.9351 -53.2574 -5.6413]

“image of how the scheme should be, the statefeedback one”

Disturb on ϕ