PRIT VARMORA

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Internship day1(10/5/2020)

Today at morning I have tried to create an hanging rotating disc for testing gyroscopic effect in V-Rep
But i have faced one problem that if I connects two bar with revolute joint then it was working fine but if I connect a cylinder with same steps I was unable to connect it via revolute joint and I have tried a lot but the problem is still remains unsolved

Then after noon I kept it as doubt and started finding and reading lots of research paper on reaction wheel its working principle and how to interpret it calculative.

But for understanding purpose I have concluded that gyroscope stores huge amount of moment in it so it maintains its position very well just because of its stored momentum and inertia but in case of reaction wheel the case is totally diffrent, it do not stores moment it just generates counter moments whenever its needs. So if we use the gyroscope to balance our bot(that I have tried in 11th standard when I firstly introduced to gyroscope) it consumes huge amount of energy to spin continuously and in case of reaction wheel it just reacts when it needed

In case of gyroscope we need to keep storing moment continuously that is required to balance max possible counter moment. But in case of reaction wheel we just need to generate counter momentum as much as required to generate at the instance of time, so according to me reaction wheel is efficient in some application.

Second thing I have looked at overview of mathematical modelling of cycle bot for that i have referred some research paper and i found one doubt in it that at the time of biped patrolling robot modelling we encountered two lagrangian equations (one for translation motion and second for rotational motion but) but when i referred research papers for cycle bot they all had encountered only one common equation of lagrangian and they have included both in linear and translation and rotational motion in one equation, it has scrambled me so please help me to understand it.

I found one use full research paper that i have shared in recourses group.
We also had and team voice call meeting today, the agenda was to distribute work along the team members and we have mutually decided that @hrithvik will work on program logic designing and till then @aniket will work on physical model designing first and then he will join @hruthvik for programming in v-rep, parallelly i will focus on developing mathematical modelling and required programs in Sci-lab for generating performance graphs and PID controllers.

As the conclusion day was great for concept clearance and worse for implementation for me

Internship day 2(11/5/2020)

Today I have tried to make an code for deriving model for system using Lagrange algorithm but for that i tried to use sci-lab but it was showing me errors for defining symbolic variables i tried manually packages but couldn't able to resolve error, then i tried using octave but there also i found some errors but i tried installing symbolic package directly from forge and also bounded pkg from git hub but it didn't worked so for now i have started to develop program in matlab but this issue took my 5-6 hours and still its unsolved.

Other then it i have took logical understanding and overview about PID controller working but still calculations and simulation process is remaining.
For logical understanding i have referred this video series.

PID: https://www.youtube.com/playlist?list=PLn8PRpmsu08pQBgjxYFXSsODEF3Jqmm-y

Other than it we have attended an meeting its details are like this:

Meeting agenda: To communicate with mentor and doubt solving.

Asked question,

1) How to use git hub and respiratory and what are they?
- Git hub is an platform that provides easy tools to manage codes and other component, docs. and its modification hierarchy.

1) How Hight of centre of mass Effects stability and which better?
   To understand it we have referred example of seesaw and discussed that as the Hight of COG is higher it requires more rapidity of motor to counter balance turbulence and visa versa.

2) What if we keeps same hight of centre of gravity but changes Hight of reaction wheel?
   If we increase Hight of reaction wheel it requires less counter moment to balance and visa versa.

internship day 3(12/5/2020)

To day I have tried to figure out mathematical model of state space modelling and transfer function modelling and to simulate performance I have created model using PID controller in Matlab to understand & test PID controller but I failed and the problem is remaining to solve after solving this problem i will tune this PID gain matrix. Other then this I have also compared LQR and PID controllers and to understand diffrence between them for that i found this research paper most useful.
PID vs LQR : http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.545.6096&rep=rep1&type=pdf

As a key conceptual diffrence i have found that the PID controller works with error signal Werther LQR controller works with states of the system and then scaled reference signal gets substituted to generate input signal for system
Second main diffrence i have found that was LQR controller is an Morden approach for used with state space modelling whether PID is conventional method to controle system used with transfer function of system modelling.

To day I have also revisited performance parameters of a controle systems and state space modelling and transfer function modeling.

Today we have also took a meeting

Agenda : to talk about each other's works and facing difficulties

In the meeting @aniket has shown a physical model designed in V-rep (inverted pendulum with rotating disk) as aniket and hrithvik is now working on V-rep for implementing code we all were in doubt for how to implement PID controller in V-rep so we have decided that aniket and hrithvik will continue to V-rep and till then i will continue to mat-lab , scilab and mathematical modeling and derivation of K(gains).

#interenship day 4 (13/5/2020)

Today i have mainly searched about mathematical modeling and noticed some points.

Unlike other type of inverted pendulum such as rotary or cart they require a runway or platform to balance itself

because it is balanced by motion of the whole pendulum. However, reaction wheel inverted pendulum is balance by torque generated by the motor. This requires no platform or runway making it compact and rigid.

As mentioned above the height is designed to be 50 cm because shorter height only generates small amount of torque to counter balance the pendulum. Although greater height generates more torque, however the torque generated by the weight is also increases as the height increases. Thus, 50 cm is the optimum height for the inverted pendulum.

I have made an module in matlab - simulink to test behaviour of system and also implemented PID controller within it and tried Ziegler-Nichols tuning method to tune behaviour of system.
And finalised the Kp, Ki, Kd. For system.

System equation :

$$\frac{s^2+1}{-1*(Id+Ip)s^4+-1*(Id+Ip)s^2+(Wd*Ld + Wp*Lp)}$$

System physical Parameters:

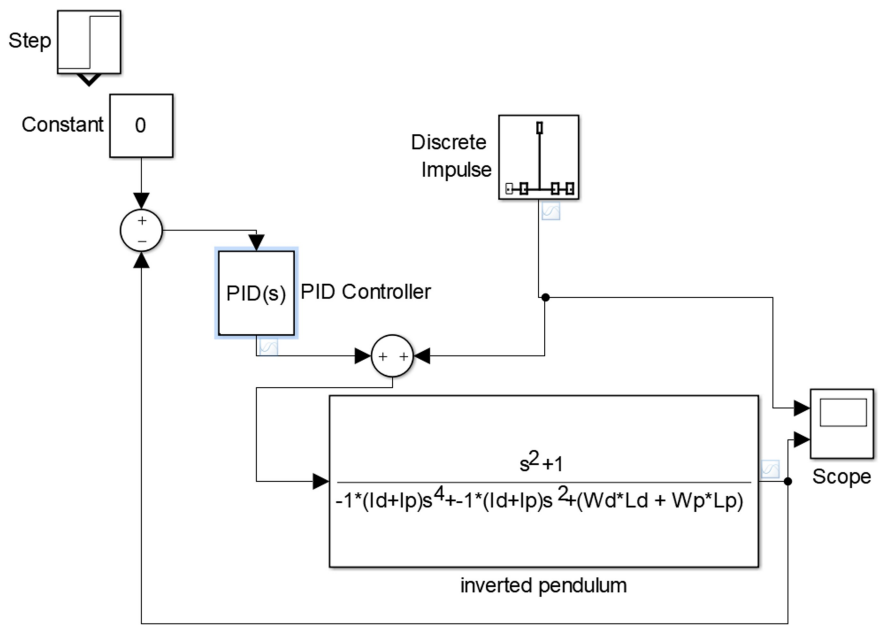
Mg	312gram
Mp	125gram
Ld	50cm
Lp	30cm
Id	0.5
Ip	0.0204

The derived finalized gains are as below.

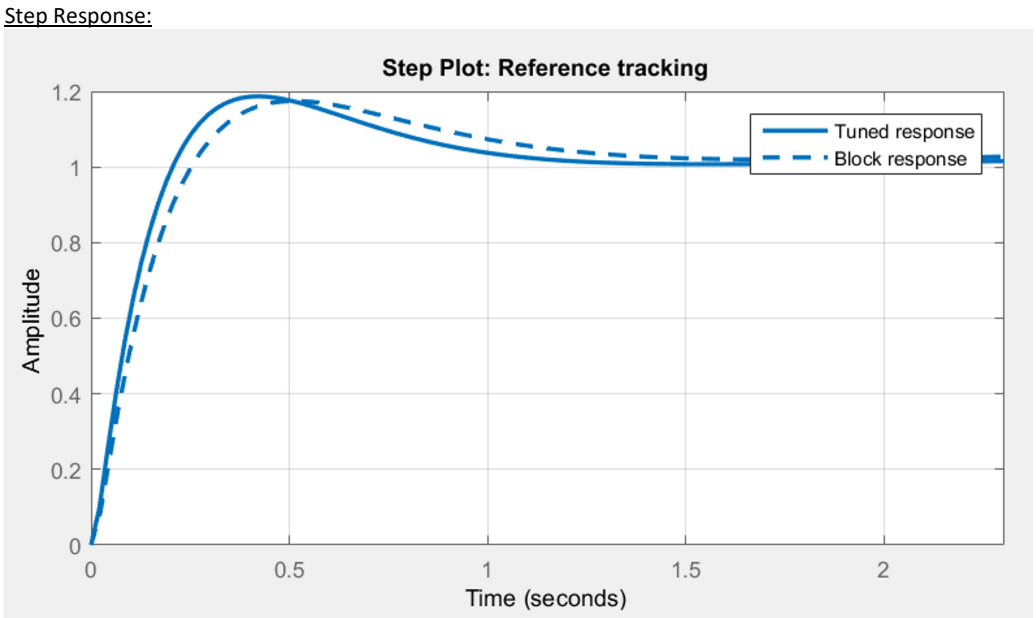
Controller Parameters	
	Tuned
P	-11.8624
I	-3.5098
D	-4.249
N	91.0806

Performance and Robustness	
	Tuned
Rise time	0.363 seconds
Settling time	3.37 seconds
Overshoot	16.8 %
Peak	1.17
Gain margin	-18.1 dB @ 0.909 rad/s
Phase margin	3.25 deg @ 0.992 rad/s
Closed-loop stability	Unstable

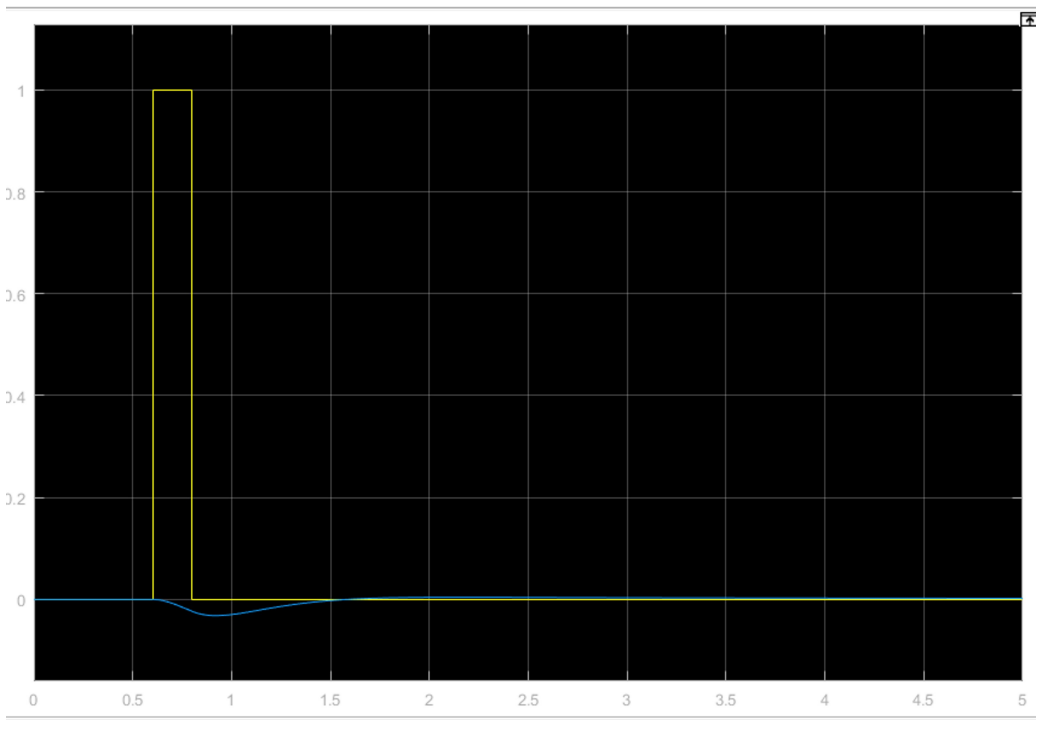
System Block Diagram:



Step Response:



Response when Disturbance occurs:


1
0.8
0.6
0.4
0.2
0
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5