Adaptive Passivity Based Controller Algorithm

$$\tau = [\sin\theta \quad v \quad a]\begin{bmatrix} mgd \\ f_v \\ I \end{bmatrix} - K_v r$$

$$\bar{\alpha} \rightarrow$$

A) Generate Trajectories, Initial states and $\bar{\alpha}(0)$

B) Calculate r $\quad r = \dot{e} + \Lambda e$

$\dot{r} = \ddot{e} + \Lambda \dot{e}$

C) Calculate $\dot{\bar{\alpha}}(0) = -\Gamma^{-1} Y^T r$

Γ : 3X3 symmetric Positive definite matrix

$Y = [\sin\theta \quad v \quad a]$

$a = \ddot{q} - \dot{r}$

$v = \dot{q} - r$

D) $\bar{\alpha}(1) = \bar{\alpha}(0) + \dot{\bar{\alpha}}(0) * \Delta t$

substitute in Torque

E) $\tau = Y\bar{\alpha}(i) - K_v r$

Feed it to the original system.

F) $\ddot{\theta} = I^{-1}(\tau - f_v\dot{\theta} - mgd\sin\theta)$

solve using the ODE

Robust invese Dynamics Controller Algorithm

A) Generate Trajectory, initial states.

B) Assume

$\gamma = [\gamma_1 \quad \gamma_2 \quad \gamma_3 \quad \gamma_4]$

Kp : Positive definite gain matrix → in this case scalar

Kd : : Positive definite gain matrix → in this case scalar.

B) get $\rho = \gamma_1 \overset{\theta}{\|q\|} + \gamma_2 \overset{\dot{\theta}}{\|\dot{q}\|} + \gamma_3 \overset{\dot{\theta}^2}{\|\dot{q}\|^2} + \gamma_4$

C) calculate v Base on the following condition:

if $(B^T * P * X) > 3$

$$V = \frac{-B^T * P * X * \rho}{\| B^T * P * X \|}$$

else:

$$V = \frac{-B^T * P * X * \rho}{3}$$

where: 3 is a Picked up Positive value.

P: Positive definite matrix.

X: error state vector

D) Calculate aq

$$a_q = \ddot{q}_d - K_P e - K_D \dot{e} + v$$

additional input to overcome disturbance

E) $\tau = \bar{I} a_q + \bar{f}_v \dot{\theta} + \bar{m} g d \sin\theta$

F) $\ddot{\theta} = I^{-1}(\tau - f_v \dot{\theta} - m g d \sin\theta)$

HW6-Results

Mostafa Atalla

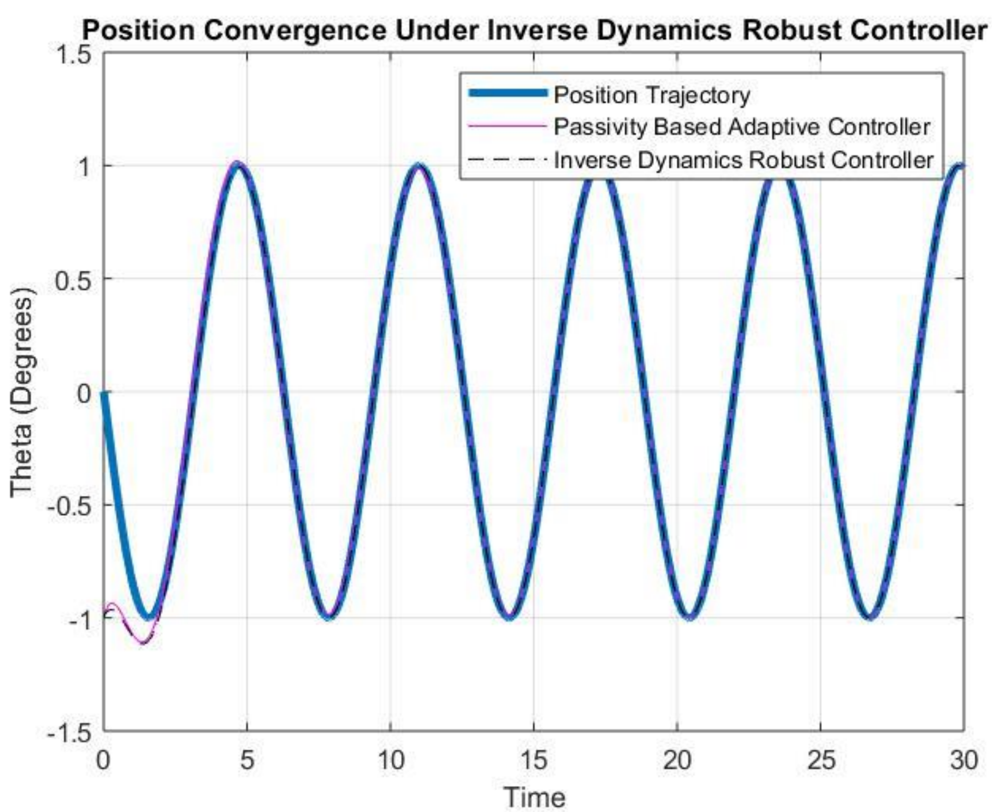
Adaptive Passivity Based Controller

```
x0=[-1 0.5];
tf=30;
lambda=1;           %Lambda Square positive definite matrix for lyapanuv Based Controller.
kv=10;                                  %Kv matrix.
L=[0.6 0 0;0 0.1 0;0 0 0.3];            %Symmetric Positive definite matrix
```

The values of L matrix has been deduced after many iterations to make the parameters error to converge to the original one, however, when I try it using different initial conditions it does not converge to the same extent. Example shown below with different initial state.

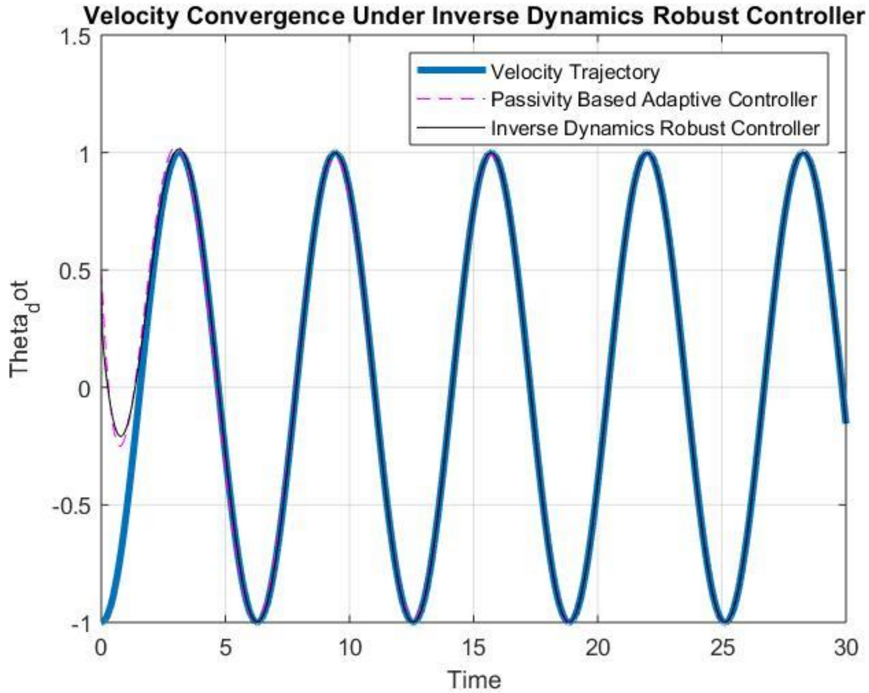
Robust Inverse Dynamics Controller

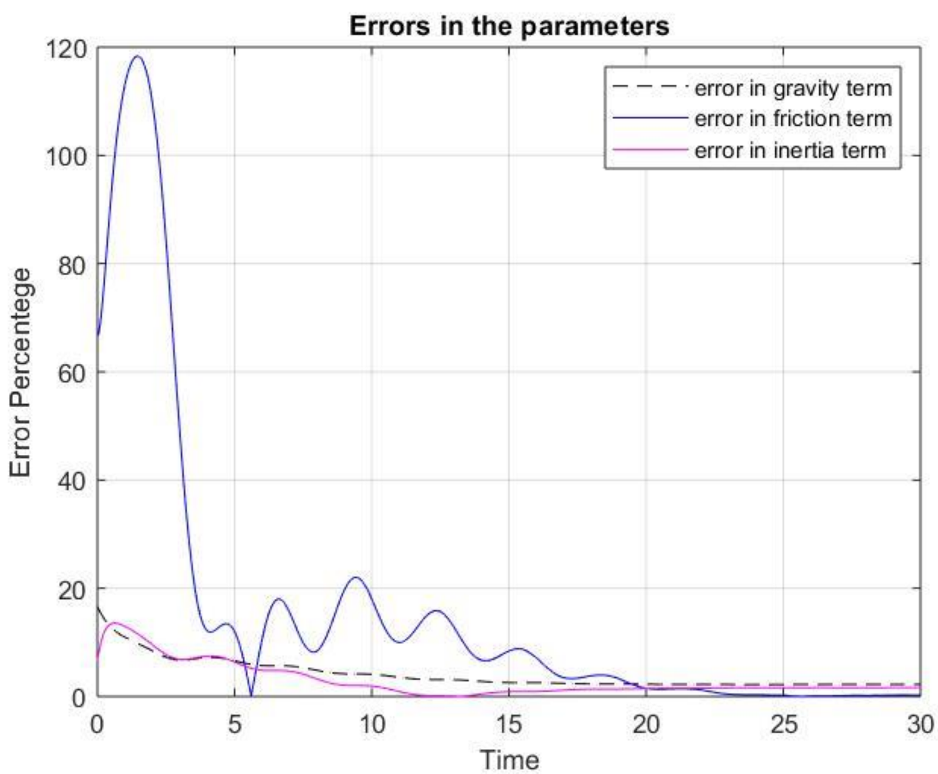
```
gama=[10 10 10 10];
p=[1 0;0 1];
B=[0;1];
kp=40;
kd=30;
```



HW6-Results

Mostafa Atalla





HW6-Results

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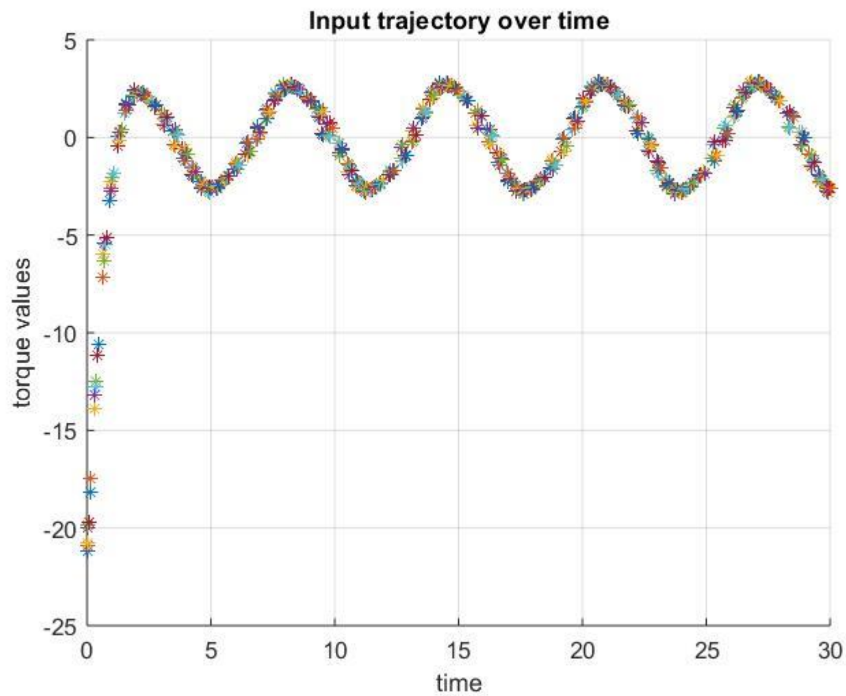
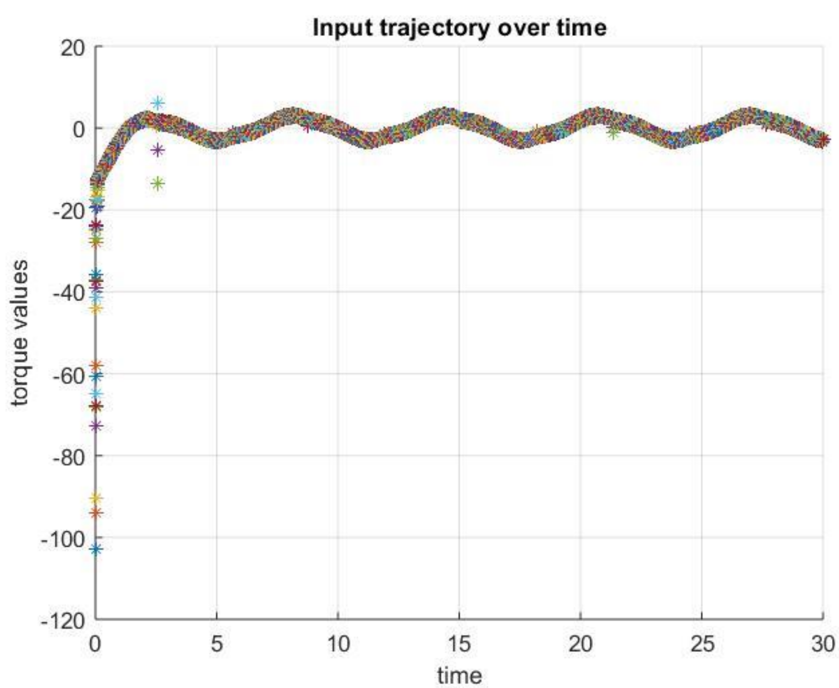
The input torque to the system using the **Adaptive Passivity Based Controller .** (plotted point by point) From a high level, we can observe that the profile goes to be like the desired trajectory which makes sense.



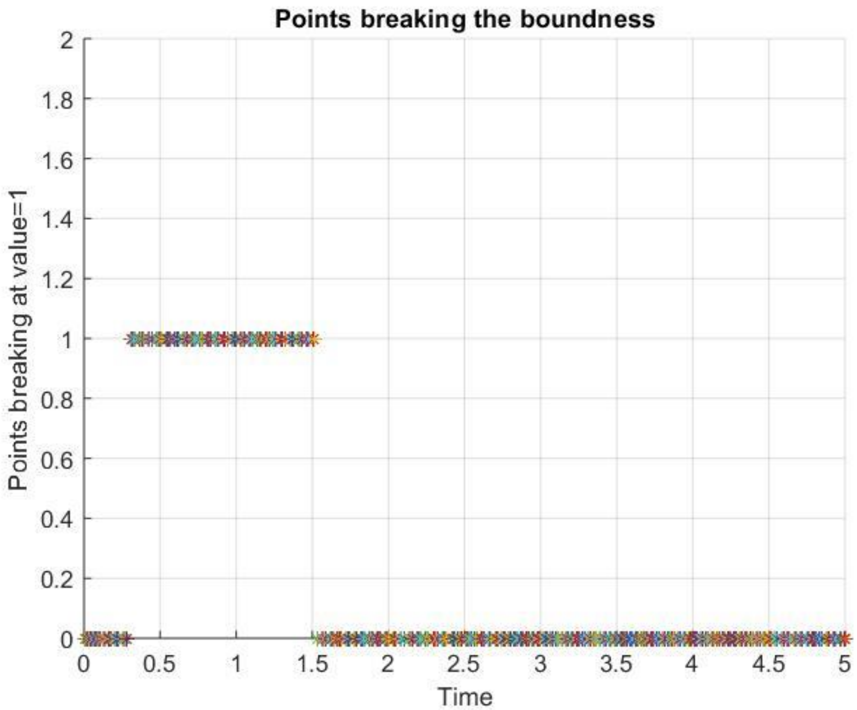
The input torque to the system using the **Robust Inverse Dynamics Controller.**



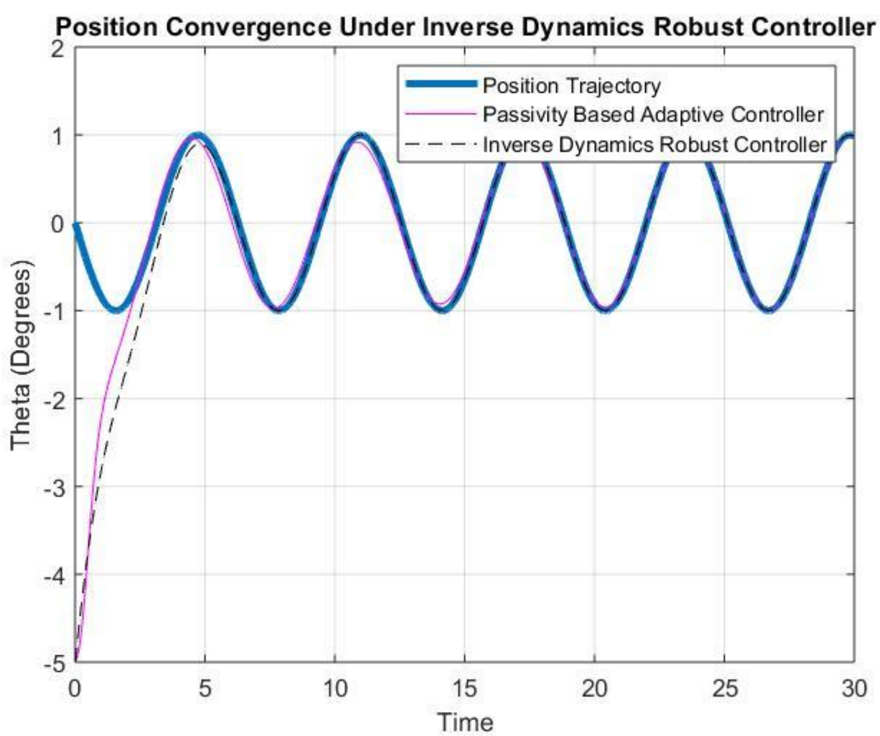
HW6-Results

Mostafa Atalla

```
Although we can see here that there are points violating the disturbance bound of the
robust controller, it can converge. So it is no a sufficient bound.
```




```
For x0=[-5 0.5];
```



HW6-Results

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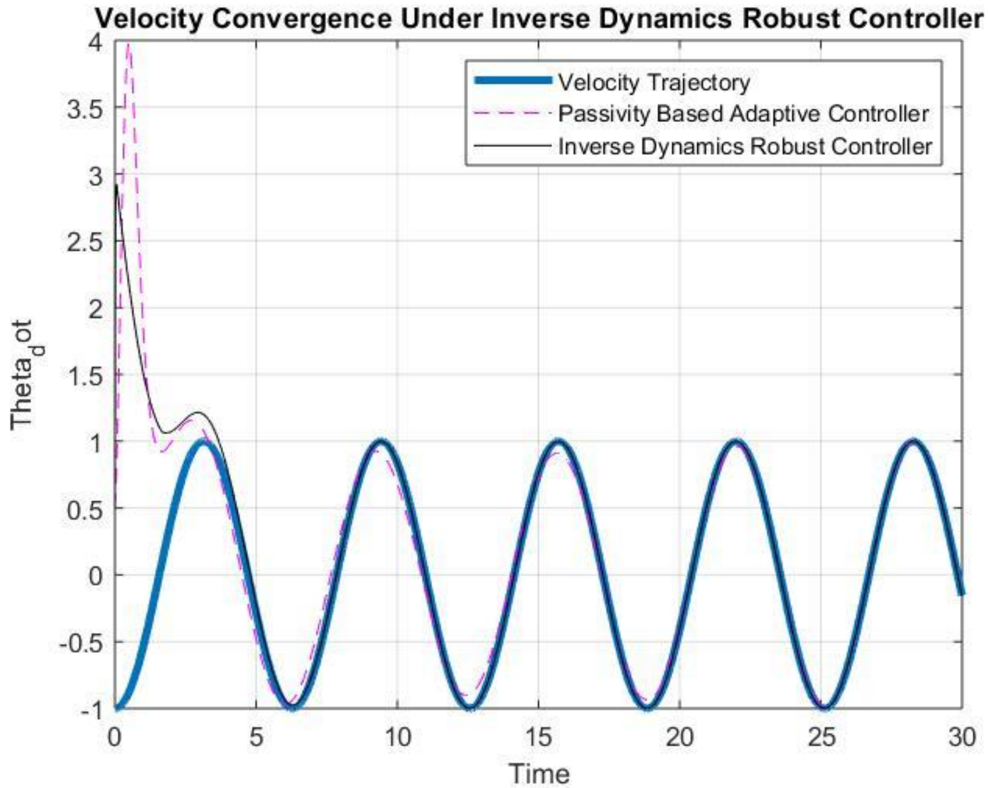

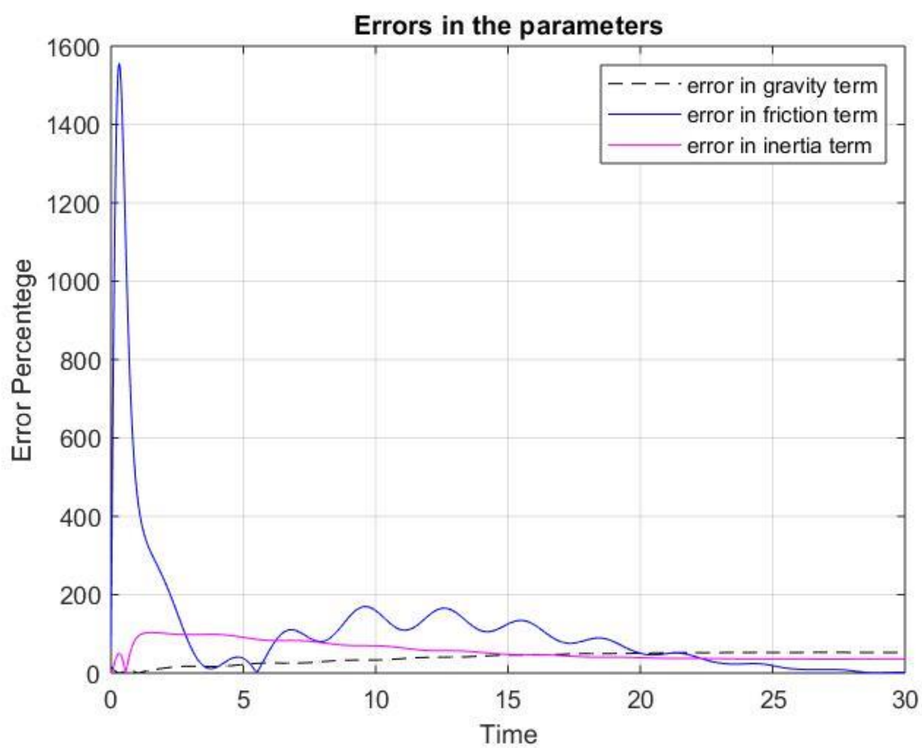

HW6-Results

Mostafa Atalla

For the input trajectory we can see that the input torque is eventually following the sinusoidal desired trajectory. The same note: the input is then following a sinusoidal trajectory according to the desired trajectory. The same we get for the robust inverse dynamics controller.