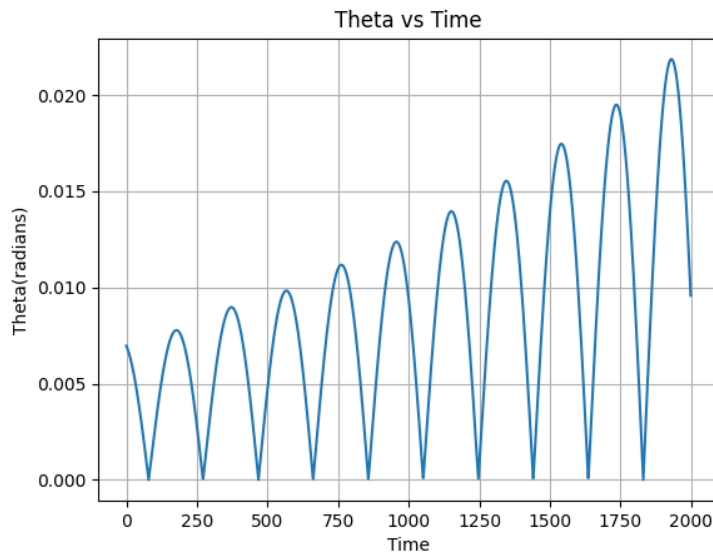


Homework 2 Report

Jiahang Wang(261011319)

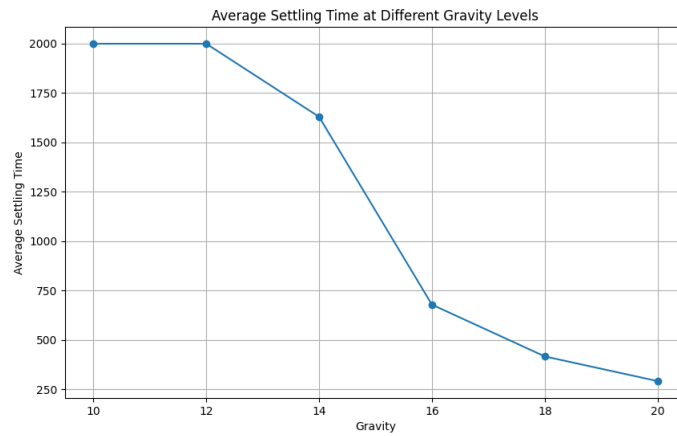
B



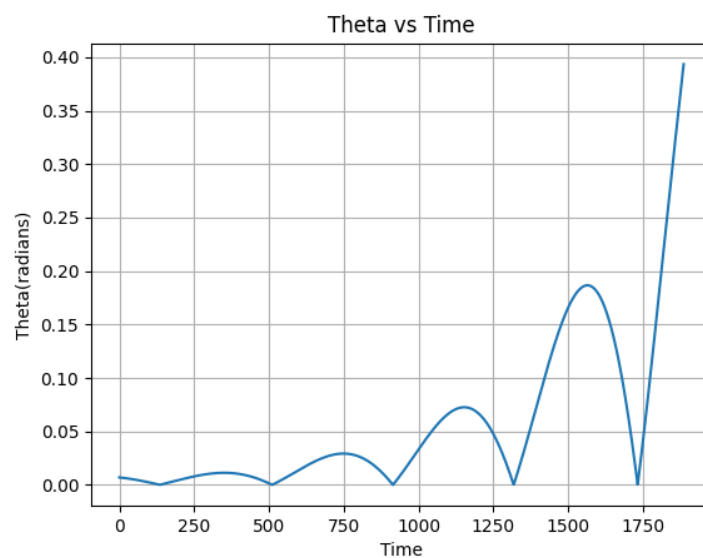
- In the experiments, the parameters that demonstrated better performance were: $K_p=2$, $K_i=0.001$, $K_d=1$, resulting in a relatively stable system.
- Analysis
 1. **High K_p** : Causes aggressive control and extreme oscillations or instability. **Low K_p** : Results in weak control, slow response, and lasting errors.
 2. **High K_i** : Leads to overshooting and instability due to aggressive error correction. **Low K_i** : Fails to eliminate steady-state errors, reducing effectiveness.
 3. **High K_d** : Makes the system “noisy” and overly reactive, risking instability. **Low K_d** : Insufficient damping, causing overshoot and oscillations.

C

- While maintaining the previous parameters of the PID controller, there was a notable decrease in settling time with the increase in gravity force, as the intensity of K_p was insufficient to keep it balanced.(Increasing the mass had the same effect.)

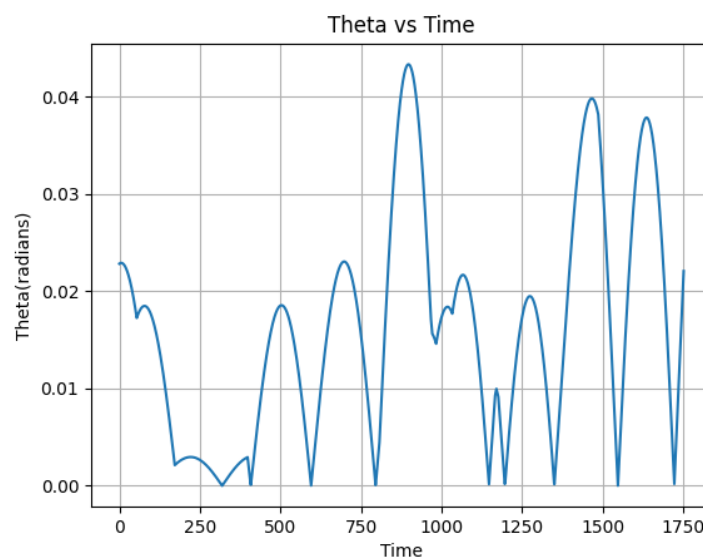


- It can also be observed from the changes in Theta that increasing gravity without increasing the strength of K_p makes the system more unstable.



D

- From the changes in Theta, it is evident that add random strong noise to the system causes overall instability, with theta values oscillating due to the noise.



- The variation in theta under noisy conditions is not very significant (despite noticeable oscillations), indicating that this PID control system has a certain degree of resistance to interference.

interesting things

- When gravity or mass increases, as long as **kp** is also increased roughly in the same proportion, the system can still maintain stability. However, such adjustments are not always linear. Theoretically, the practical scenario might be more complex as the stability and responsiveness of the system are also influenced by the integral and derivative control parameters, as well as the internal dynamics of the system and external disturbances.
- Although the variation in theta is not very significant under noisy conditions, the displacement of the cart increases quite noticeably, presenting a challenge that needs to be addressed.