ASEN 3128 - Assignment 1

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Problem 1

The following gains for the quad copter feedback were determined for a damping factor, ζ, of 0.8 and a time constant, τ, of 0.1 seconds. The method for this is shown in Figure 1.

1. $K_{L1} = 0.00136\ [N \cdot /(rad/s)]$
2. $K_{L2} = 0.0106\ [N \cdot /(rad)]$
3. $K_{M1} = 0.0018\ [N \cdot /(rad/s)]$
4. $K_{M2} = 0.0144\ [N \cdot /(rad)]$
5. $K_{N1} = 0.0012\ [N \cdot /(rad/s)]$

These gains were then implemented as follows:

1. $L_c =$ - $k_{L1} \cdot p - K_{L2} \cdot \phi$
2. $M_c =$ - $k_{M1} \cdot q - K_{M2} \cdot \theta$
3. $N_c =$ - $k_{N1} \cdot r$

$$\tau = \frac{1}{\zeta\omega_n} \Rightarrow \omega_n = \frac{1}{\tau\zeta} = 12.5 \text{ rad/s}$$

$$\frac{k_2}{I_x} = \omega_n^2 \Rightarrow k_2 = 0.0106 \text{ N·m/rad}$$

$$\frac{k_1}{I_x} = 2\zeta\omega_n = 0.00136 \text{ N·m/(rad/s)}$$

$$\left.\begin{aligned} k_{1p} &= 0.00136 \\ k_{2p} &= 0.0106 \end{aligned}\right\} \text{roll} \quad \begin{aligned} &\text{- Der} \\ &\text{- Prop} \end{aligned}$$

$$\left.\begin{aligned} k_{1q} &= 0.0018 \\ k_{2q} &= 0.0144 \end{aligned}\right\} \text{pitch} \quad \begin{aligned} &\text{- Der} \\ &\text{- Prop} \end{aligned}$$

$$k_r = 0.0012$$

$$\Delta L_c = -k_{1p}\Delta p - k_{2p}\Delta\phi$$
$$\Delta M_c = -k_{1q}\Delta q - k_{2q}\Delta\Theta$$
$$\Delta N_c = -k_r \Delta r$$

Figure 1: Work for determining gain values.

Problem 2-3

5 degree Bank Deviation

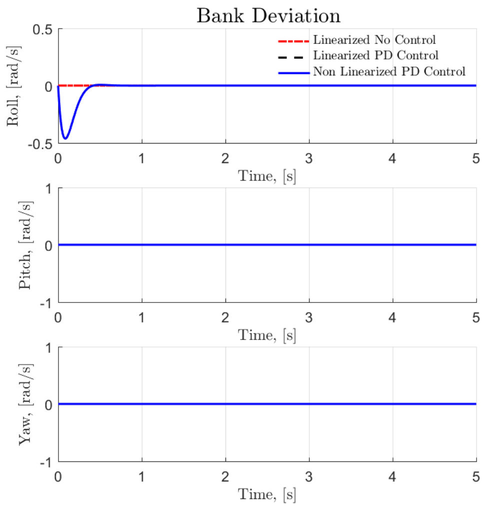

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Figure 2: Body coordinate angular velocity as a function of time.

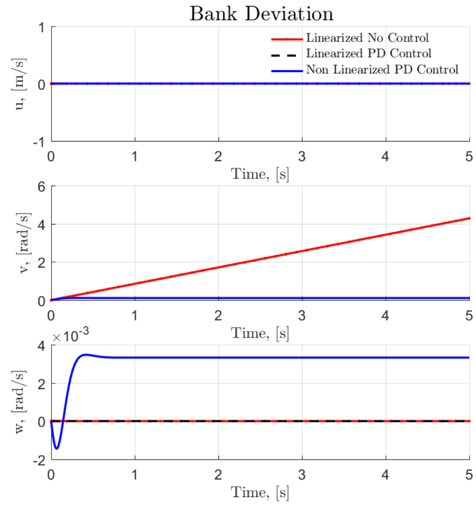

Figure 3: Body coordinate velocity as a function of time.

5 degree Elevation Deviation

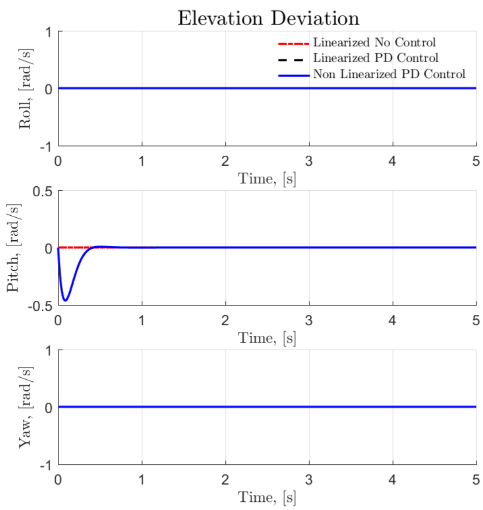

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Figure 4: Body coordinate angular velocity as a function of time.

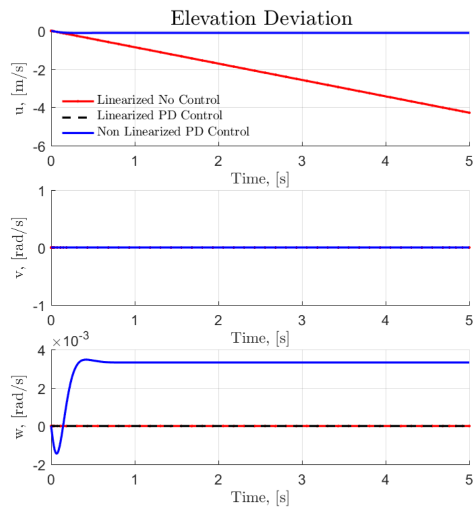

Figure 5: Body coordinate velocity as a function of time.

0.1 Rad/s Roll Deviation

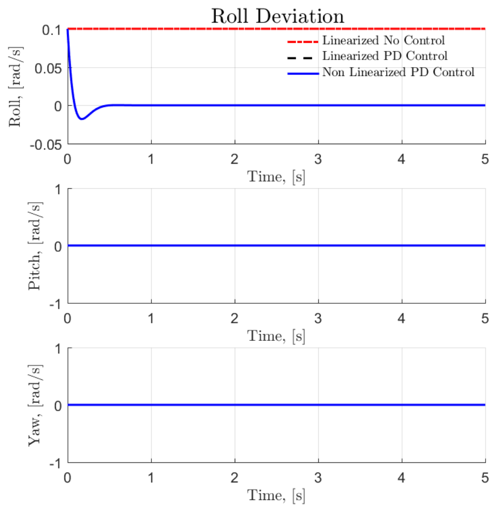

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Figure 6: Body coordinate angular velocity as a function of time.

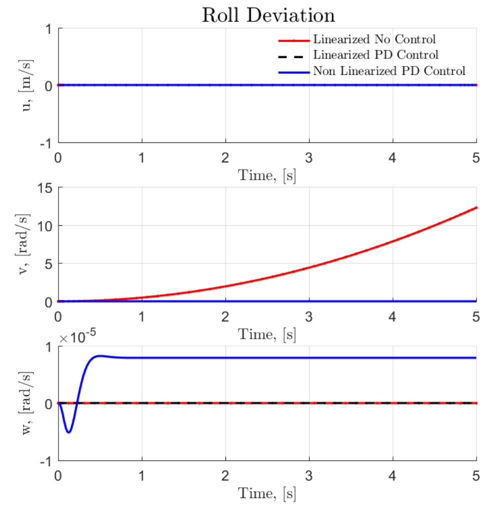

Figure 7: Body coordinate velocity as a function of time.

0.1 Rad/s Pitch Deviation

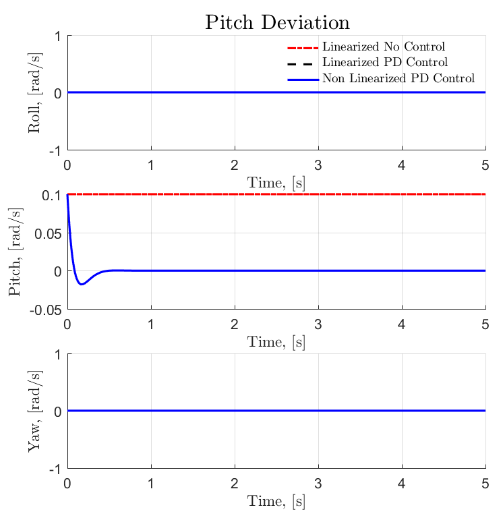

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Figure 8: Body coordinate angular velocity as a function of time.

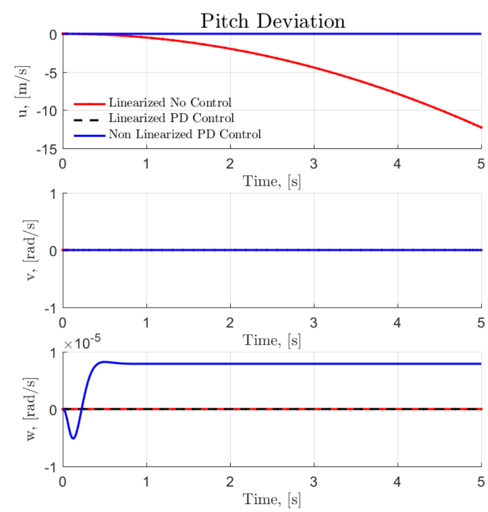
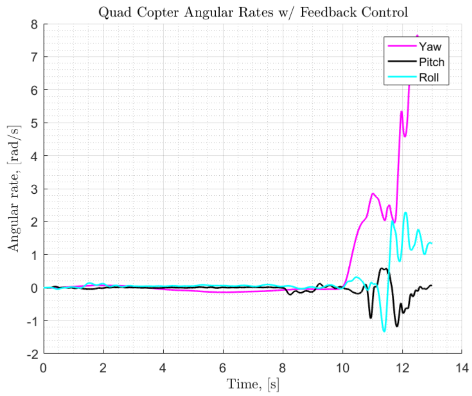


Figure 9: Body coordinate velocity as a function of time.

Problem 4



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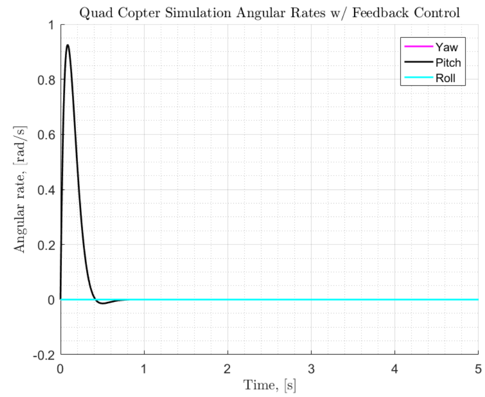

Figure 10: Actual Quad Copter Data

Figure 11: Simulated data

MATLAB Code