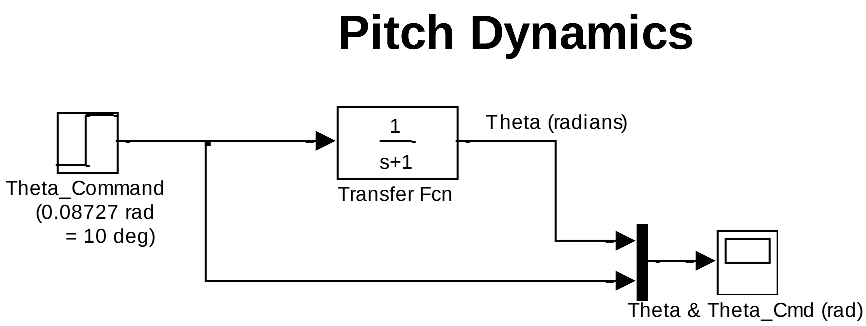
SYST 320 Class Notes
Simulink / Block Diagrams: Applications

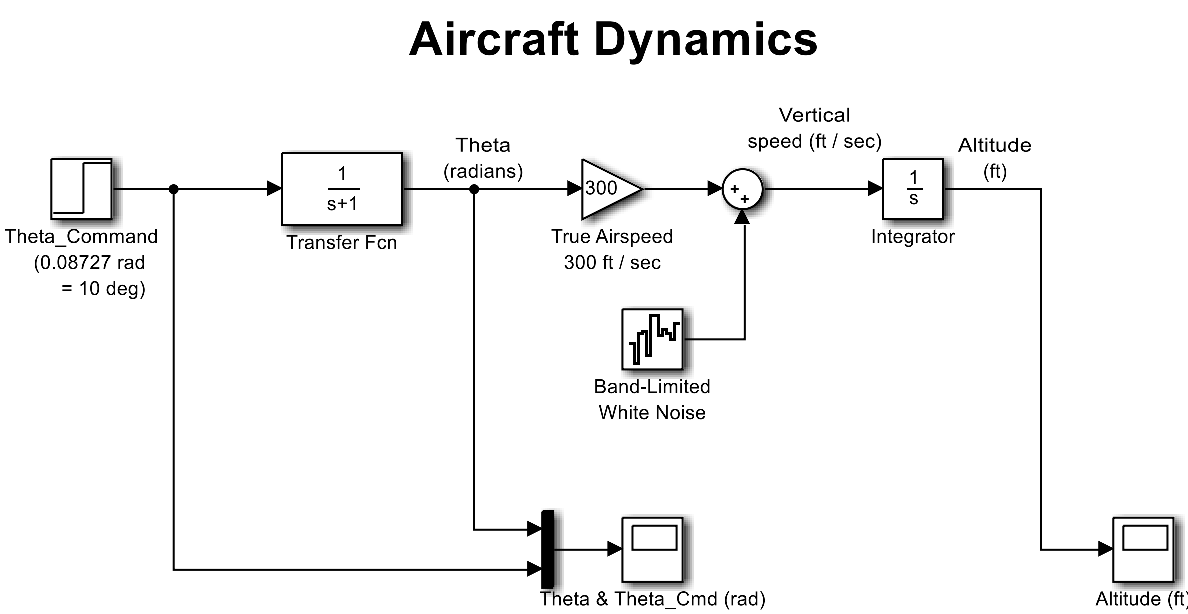
[Based on lecture given by Lance Sherry]

Aircraft Dynamics



Notes

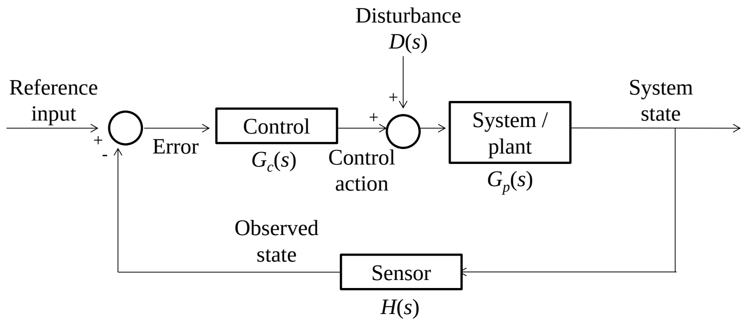
- Transfer function $\frac{1}{s+1}$ maps the input to the output for the following differential equation: $\dot{x}+x=f(t)$ (x is output, $f(t)$)
- Based on input, we are solving the equation: $\dot{x}+x=\theta_{cmd}$
- The solution is $x(t)=\theta_{cmd}(1-e^{-t})$, which represents a delay between the input and output commands.



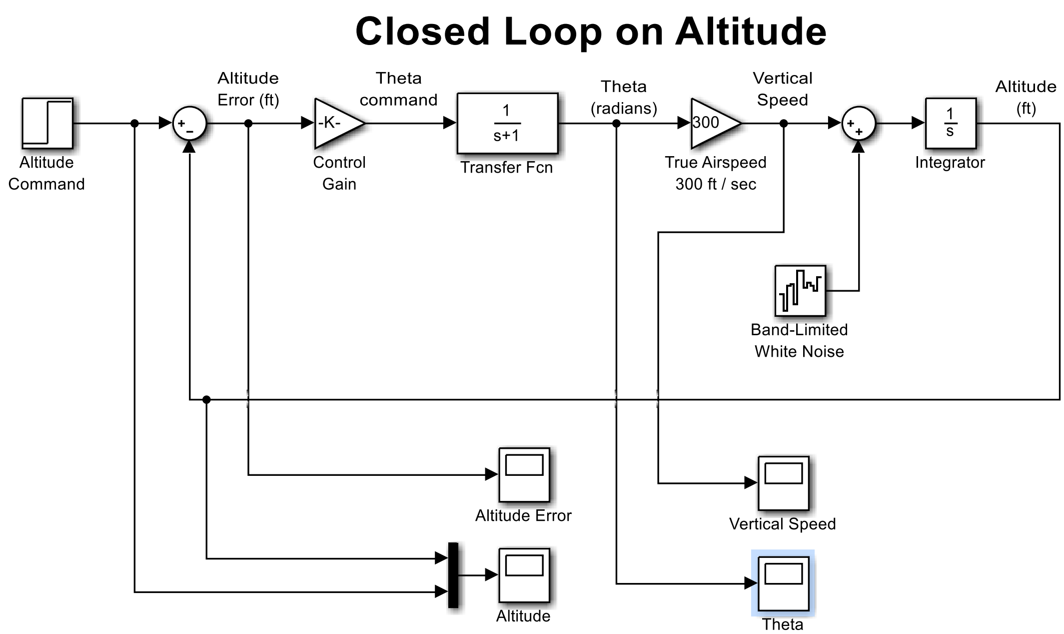
Note: For small θ, $\sin\theta \approx \theta$ (θ must be in radians).

Reason: $\sin\theta=\theta-\frac{\theta^3}{3!}+\frac{\theta^5}{5!}-\ldots\approx\theta$

Control system framework



Proportional Control: $G_c = K_p$



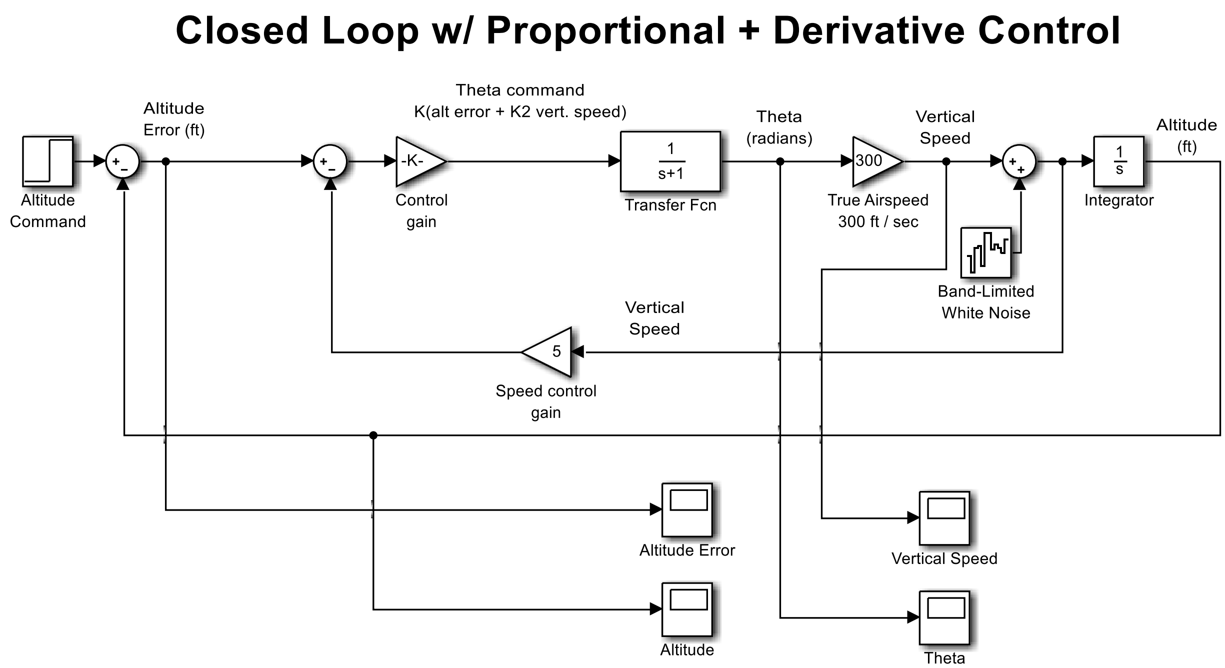
Proportional + Derivative Control

Proportional + Derivative Control: $G_c = K_p(1 + K_d s)$

Goal: Maintain altitude at some target value.
The control law is equivalent to the following:

$$\text{action} = K_p\left[(z_{\text{target}} - z_{\text{actual}}) + K_d\left(\frac{dz_{\text{target}}}{dt} - \frac{dz_{\text{actual}}}{dt}\right)\right]$$
$$= K_p\left[(z_{\text{target}} - z_{\text{actual}}) - K_d\frac{dz_{\text{actual}}}{dt}\right]$$

That is, you take positive corrective action (pitch command > 0) if you are (a) too low ($z_{\text{target}} - z_{\text{actual}} > 0$) or (b) if you are descending, or (c) some combination of the two.



Summary of outcomes:

- Example of flight dynamics and implementation in Simulink
- Understanding of two different control mechanisms
- Implementation in MATLAB and numerical experiments showing differences between control laws