## Basic Mechanics

Thrust force :

Drag moment : 

图示

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图片包含 图示

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## Dynamics and 1D Linear Control

Control of height





Second order dynamic system 

Control of a linear second-order system

**Problem**

State, input 

Plant model 

Find a control input function 

so that  follows the desired trajectory 

**General Approach**

Define error, 

Want to converge exponentially to zero

**Strategy**

Find such that



**PD Control**



Proportional control acts like a spring (capacitance) response

Derivative control is a viscous dashpot (resistance) response

Large derivative gain makes the system overdamped and the system converges slowly

**PID Control**

In the presence of disturbances (e.g., wind) or modeling errors (e.e. unknown mass), it is often advantageous to use PID control



**Effects of Gains for a PD Control System**

图片包含 游戏机, 厨房

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Stable Marginlaly Stable Unstable

  

**Vibration Function**

 

## Design considerations

 **Input, defined in terms of thrust**

**T**max **Maximum thrust, as determined by peak motor torque**

**a**max **Maximum acceleration**

  **Maximum input, as determined by maximum thrust**

**Thrust/Weight ratio******

## Agility







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Suppose ,

## Component selection

## Effects of size

* mass, inertia 
* Thrust 
* moment 
* Froude scaling 

# Axis angle

Axis u

Rotation angle 

 **Rodrigues’ formula**

R to u and 

  (u, without solving for eigenvector)

where,  is the trace of the matrix R

 encode angular velocity in body fixed frame.

 encode angular velocity in world fixed frame.



图示

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Ex: Rotate around Z Axis





ex: 2 Rotations







# Dynamics



 where L is Linear Monmentum

 where is Rotate Monmentum of frame B at point C according to A







**For translation**



**For rotation**

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# Planar Quadrotor Model







图示

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