

Attitude and Position Control of a Quadcopter in a Networked Distributed System



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Agenda



Introduction

Model

Attitude Model

Control Solution

Attitude Controller

Introduction

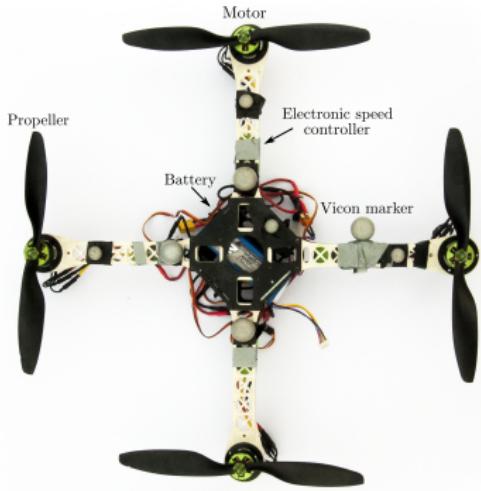


Introduction



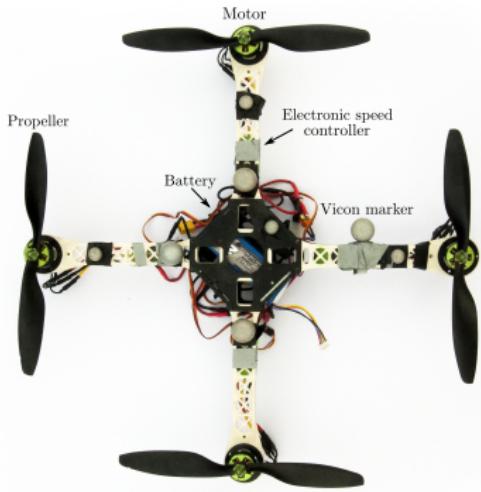
Introduction

Prototype



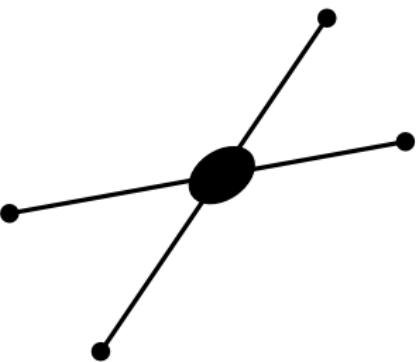
Introduction

Prototype



Model

Attitude Model

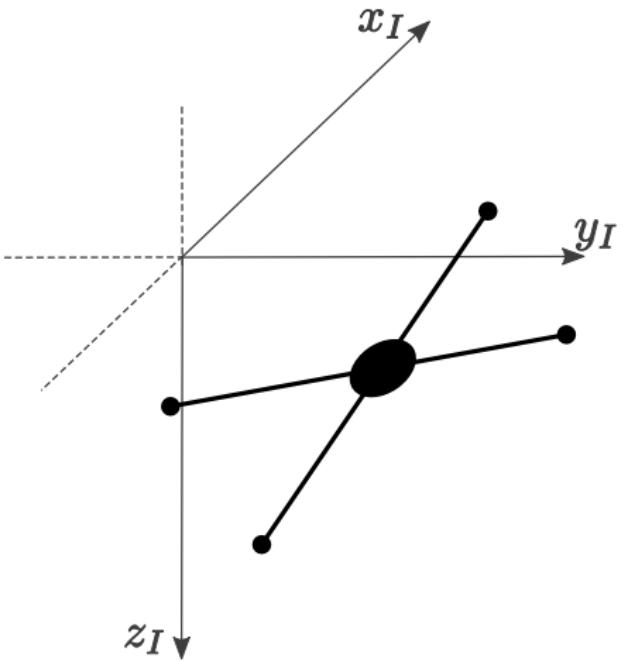


Model

Attitude Model

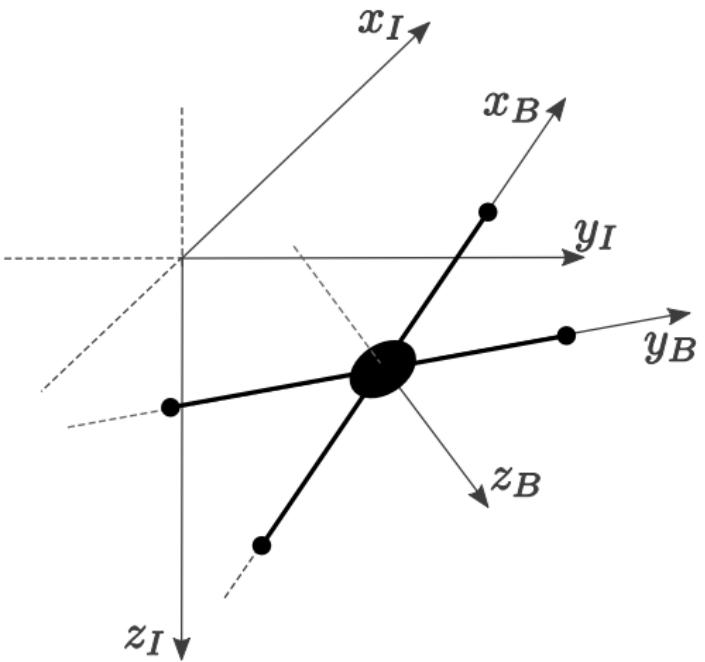


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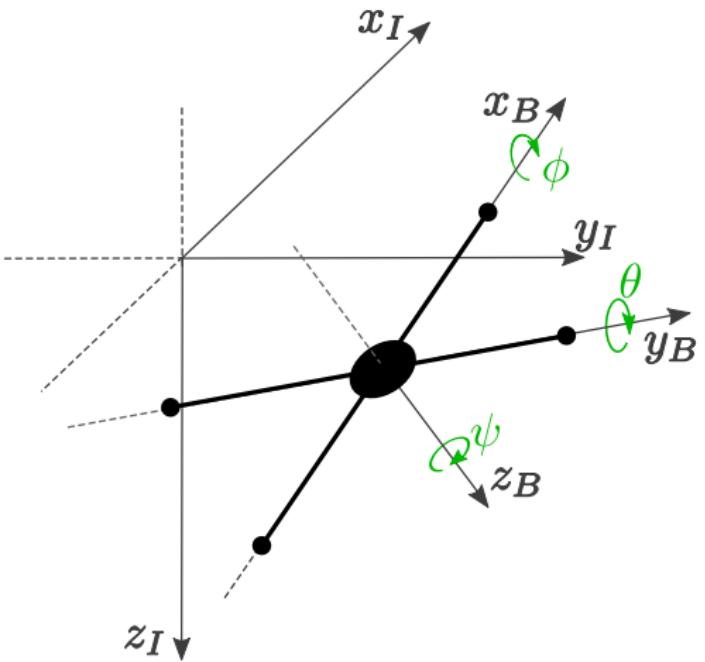
Model

Attitude Model



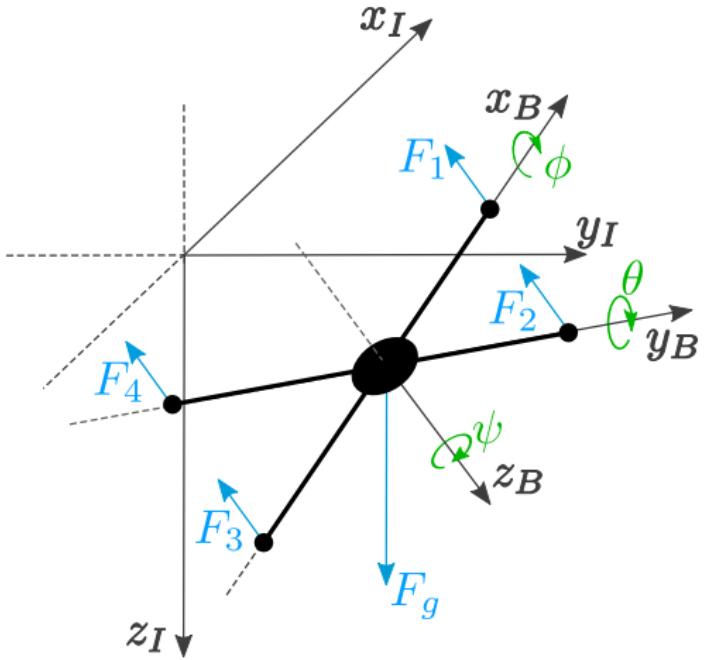
Model

Attitude Model



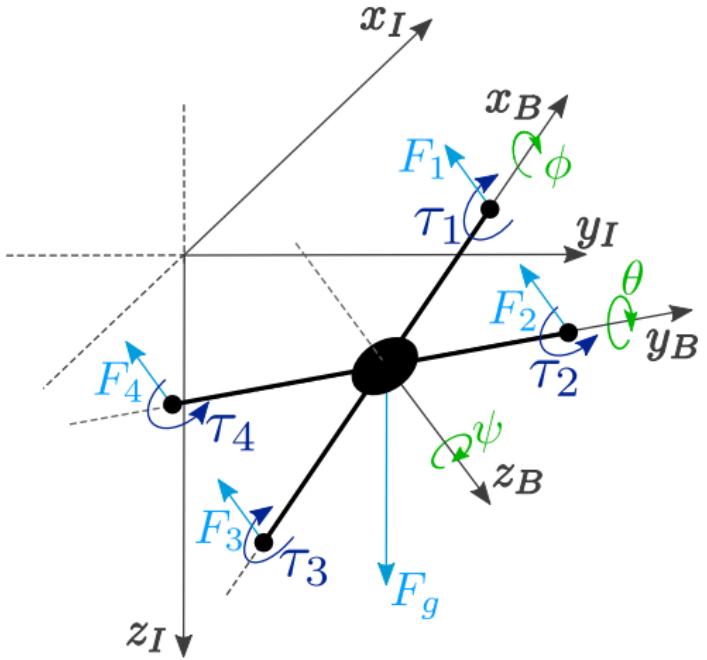
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Attitude Model



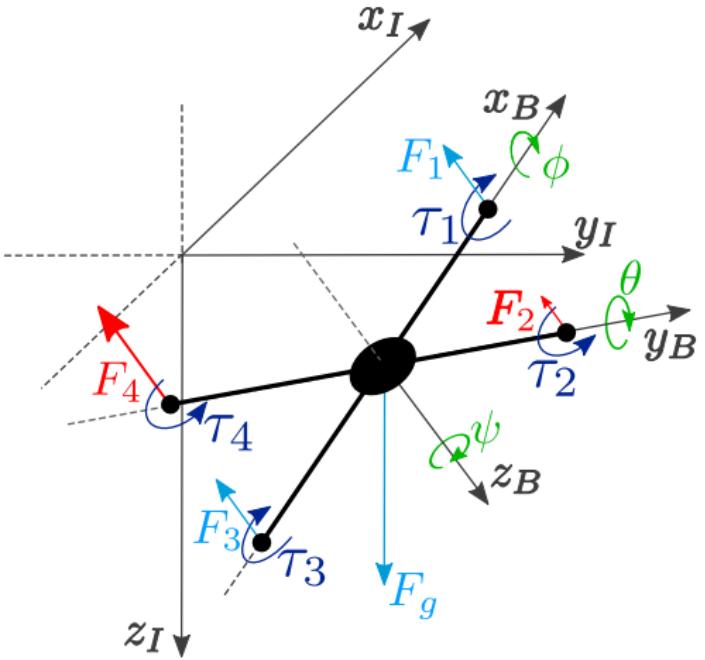
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Attitude Model



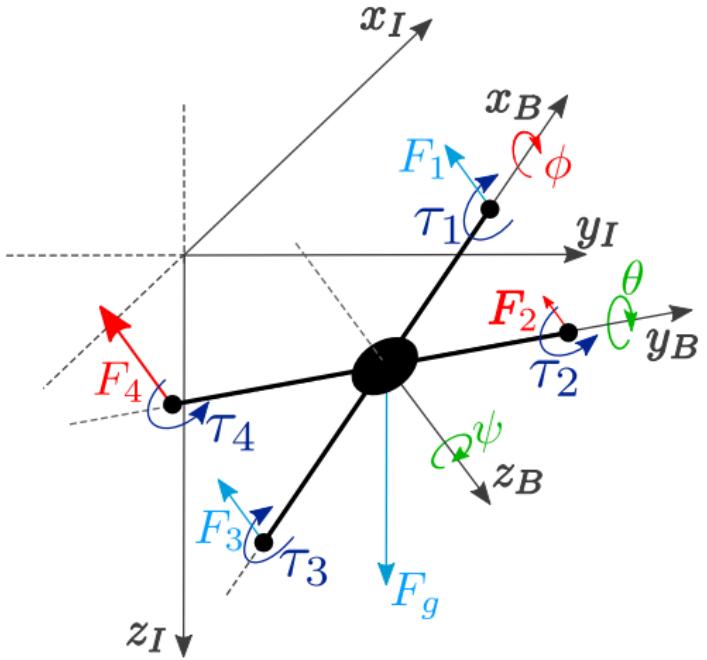
Model

Attitude Model



Model

Attitude Model



Model

Attitude Model



- ▶ Dynamic Equations

Model

Attitude Model



- ▶ Dynamic Equations

$$J\alpha = \sum \tau$$

Model

Attitude Model



► Dynamic Equations

$$J\alpha = \sum \tau$$

$$J_x \ddot{\phi} = (F_4 - F_2)L$$

$$J_y \ddot{\theta} = (F_1 - F_3)L$$

$$J_z \ddot{\psi} = \tau_1 - \tau_2 + \tau_3 - \tau_4$$

Model

Attitude Model



► Dynamic Equations

$$J\alpha = \sum \tau$$

$$J_x \ddot{\phi} = (F_4 - F_2)L$$

$$J_y \ddot{\theta} = (F_1 - F_3)L$$

$$J_z \ddot{\psi} = \tau_1 - \tau_2 + \tau_3 - \tau_4$$

$$J_x \ddot{\phi} = k_{\text{th}}(\omega_4^2 - \omega_2^2)L$$

$$J_y \ddot{\theta} = k_{\text{th}}(\omega_1^2 - \omega_3^2)L$$

$$J_z \ddot{\psi} = k_d(\omega_1^2 - \omega_2^2 + \omega_3^2 - \omega_4^2)$$

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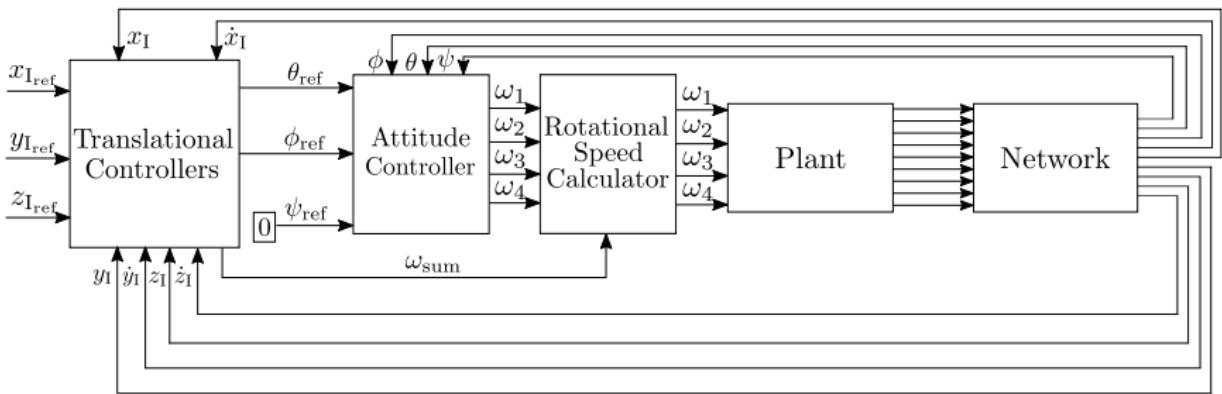
Model

Attitude Model

Control Solution

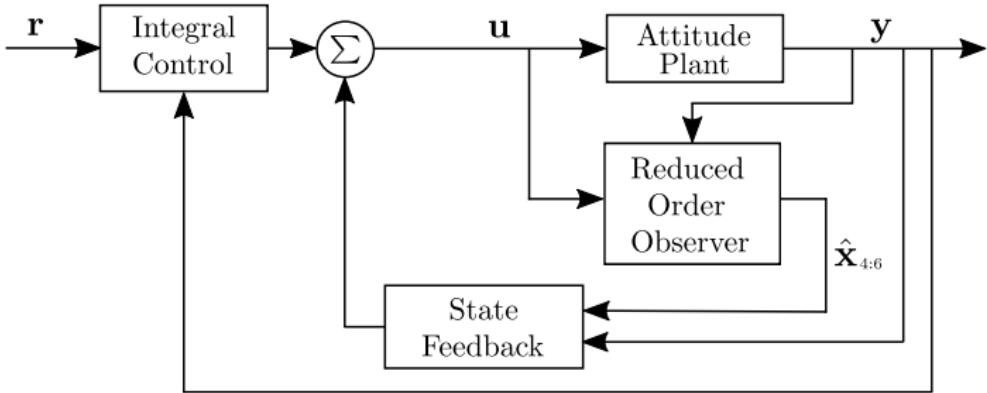
Attitude Controller

Control Solution



Control Solution

Attitude Controller



Control Solution

Attitude Controller



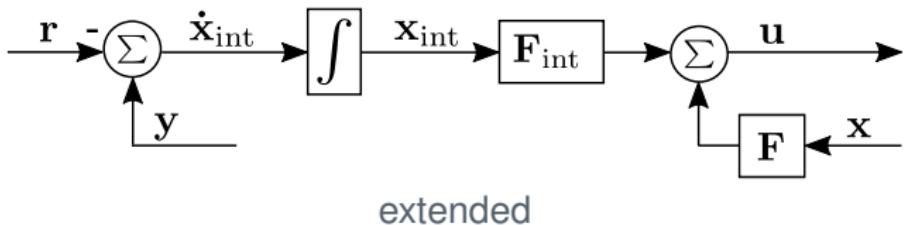
- ▶ System Representation

Control Solution

Attitude Controller



- ▶ State Feedback with Integral Control



Control Solution

Attitude Controller



- ▶ LQR

$$J = \int_0^{\infty} \mathbf{x}^T \mathbf{Q} \mathbf{x} + \mathbf{u}^T \mathbf{R} \mathbf{u} \, dt$$

- ▶ Bryson's Rule

$$Q_{ii} = \frac{1}{\text{maximum acceptable value of } [x_i^2]}$$

$$R_{ii} = \frac{1}{\text{maximum acceptable value of } [u_i^2]}$$

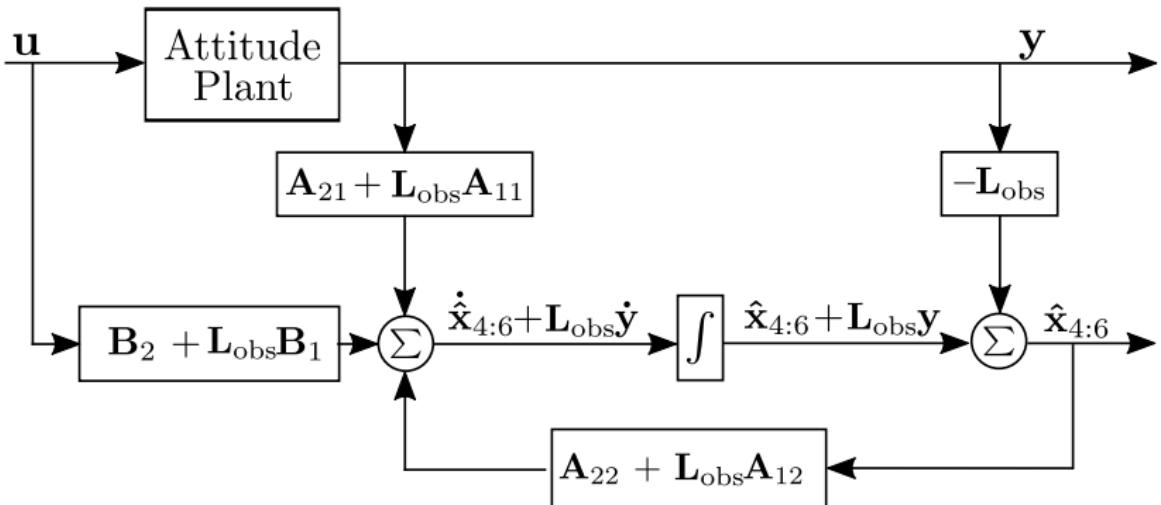
Control Solution

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- Reduced Order Observer



equation what are the states we estimate

$$A_{22} + L_{obs}A_{12}$$

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