

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



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Agenda



Introduction

Prototype

Prototype

Model

Attitude Model

Translational Model

Linearization of the Model

Network

Control Solution

Attitude Controller

Translational Controller

Implementation

Results

Conclusion

Introduction



Introduction



Introduction



Model

Attitude Model



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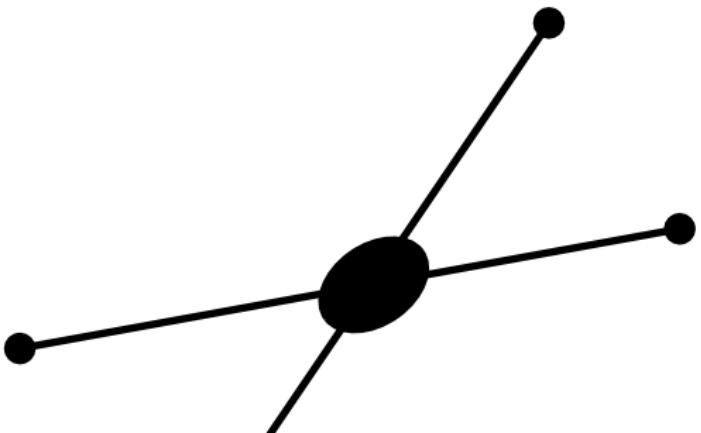
Implementation

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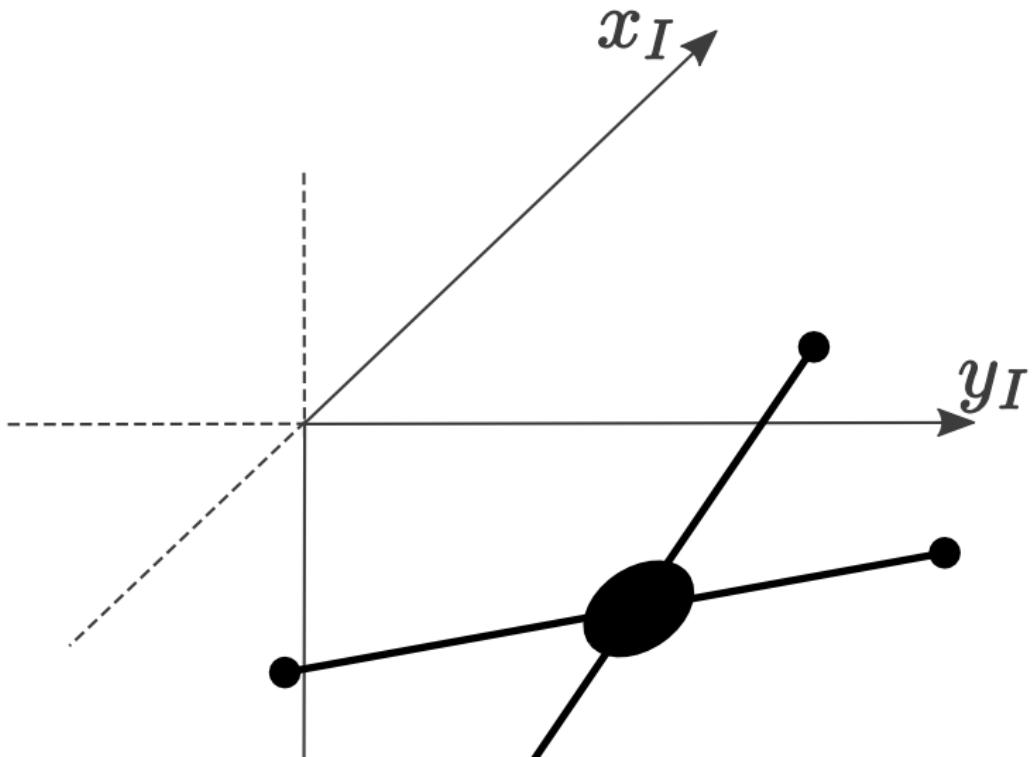
Model

Free Body Diagram



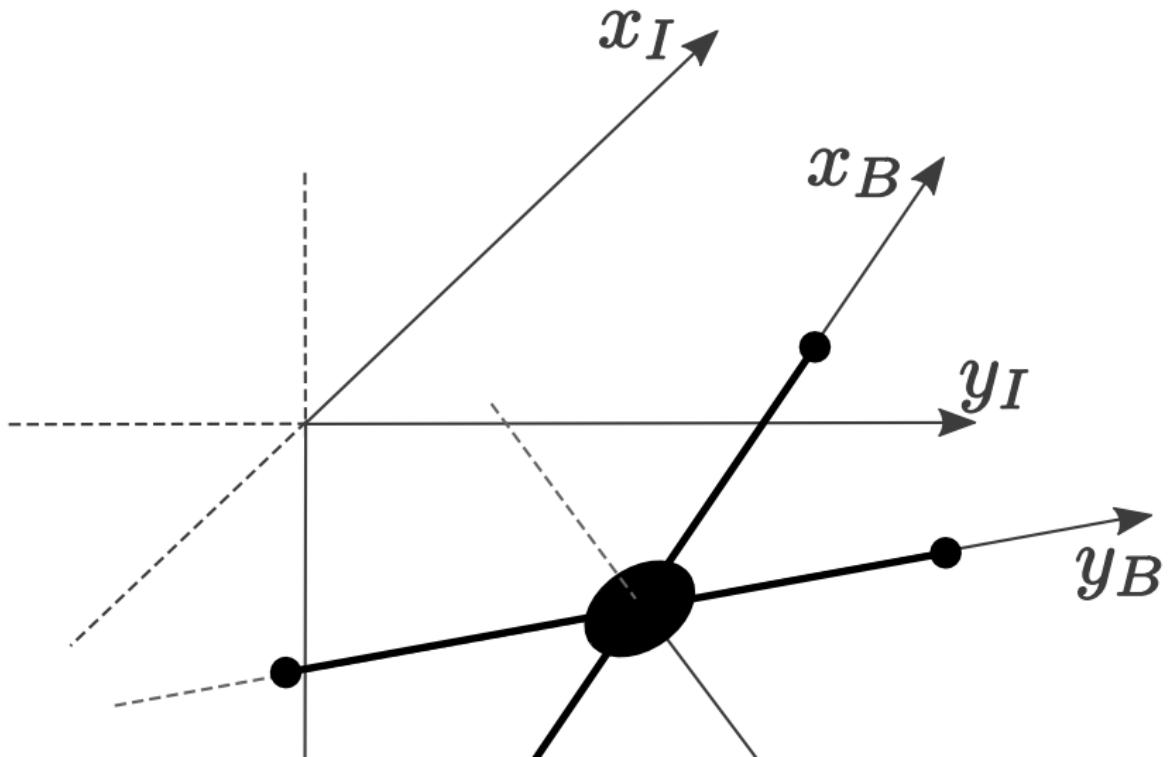
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Free Body Diagram



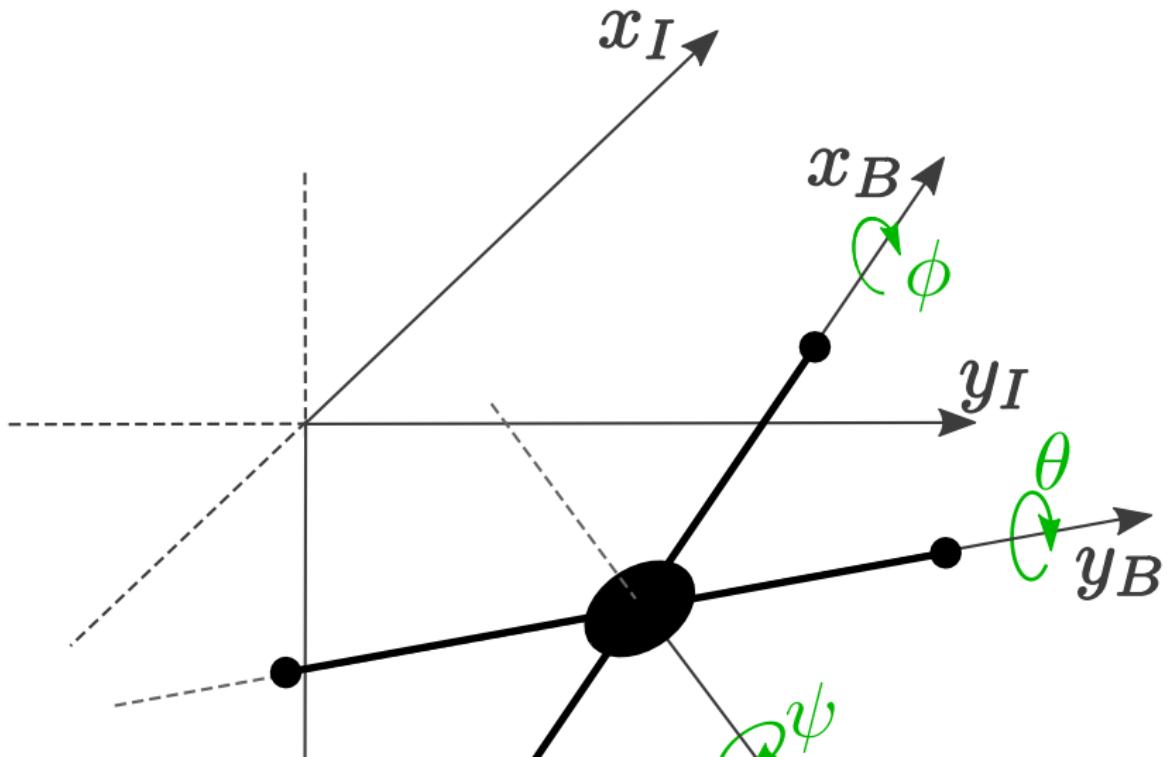
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Free Body Diagram



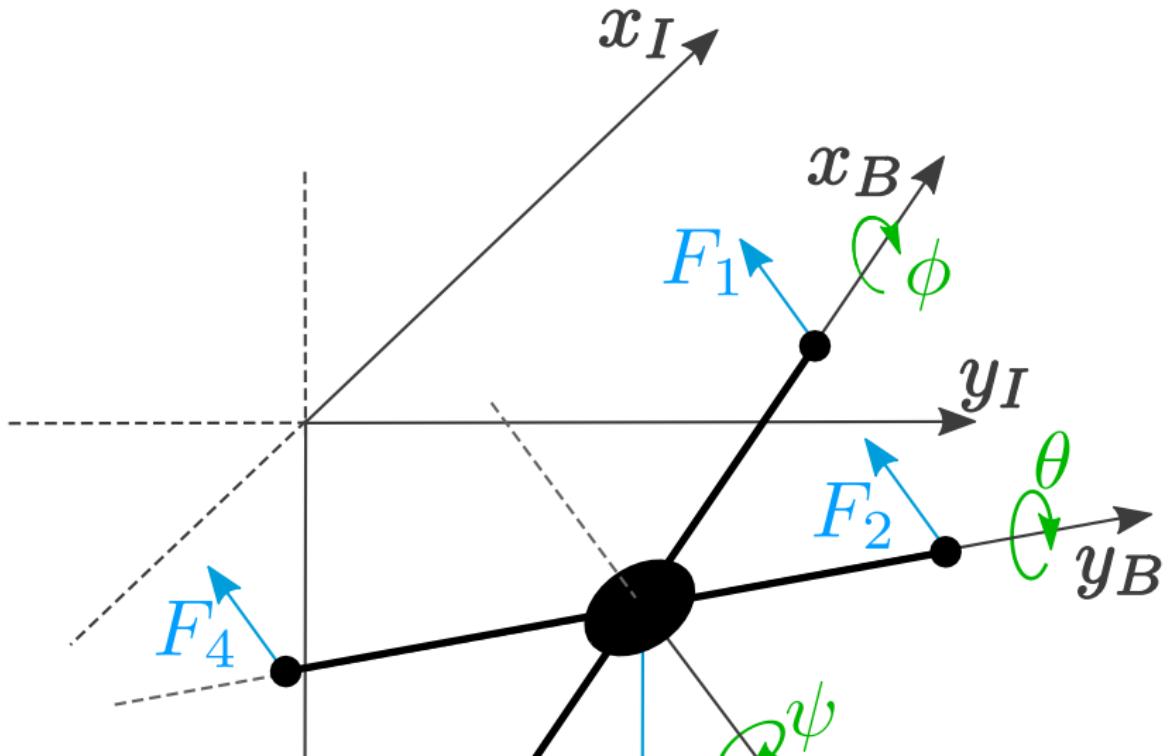
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Free Body Diagram



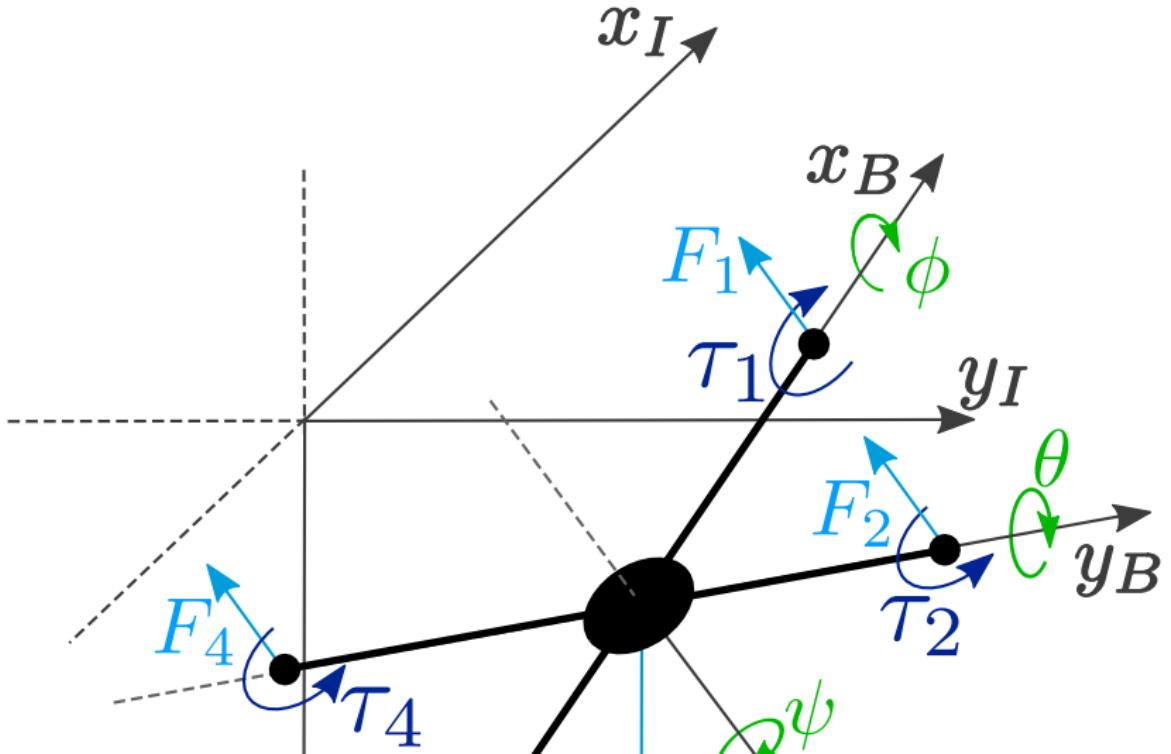
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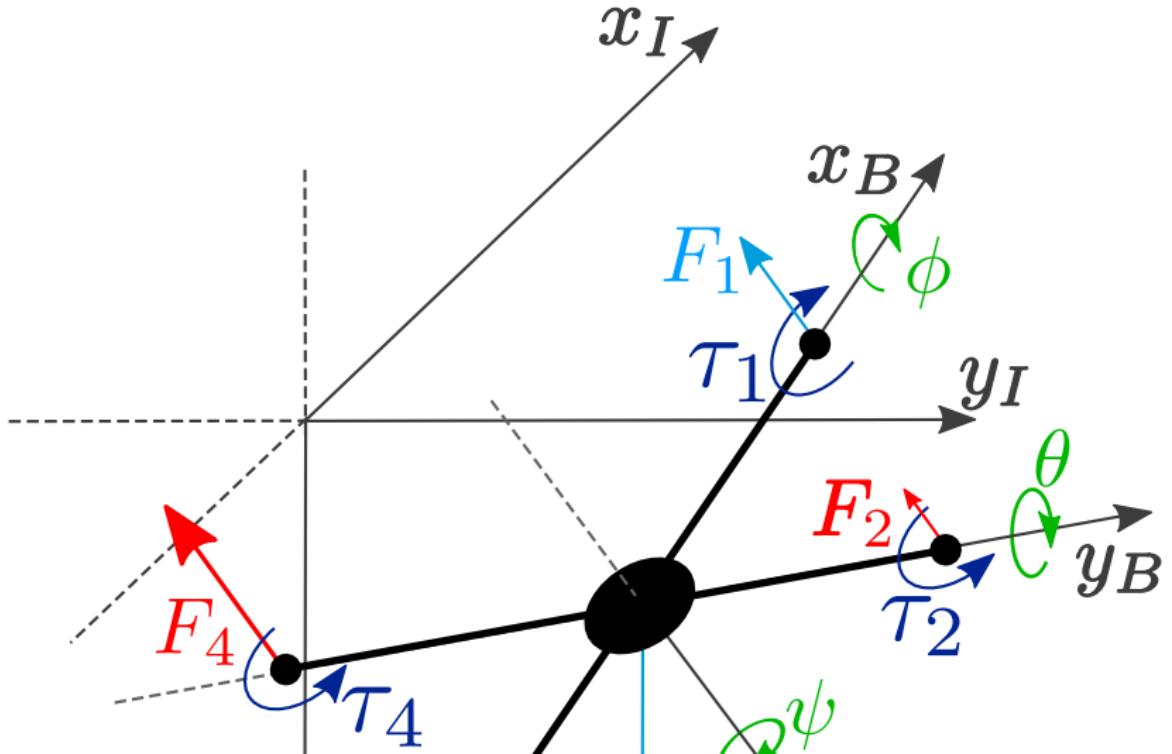
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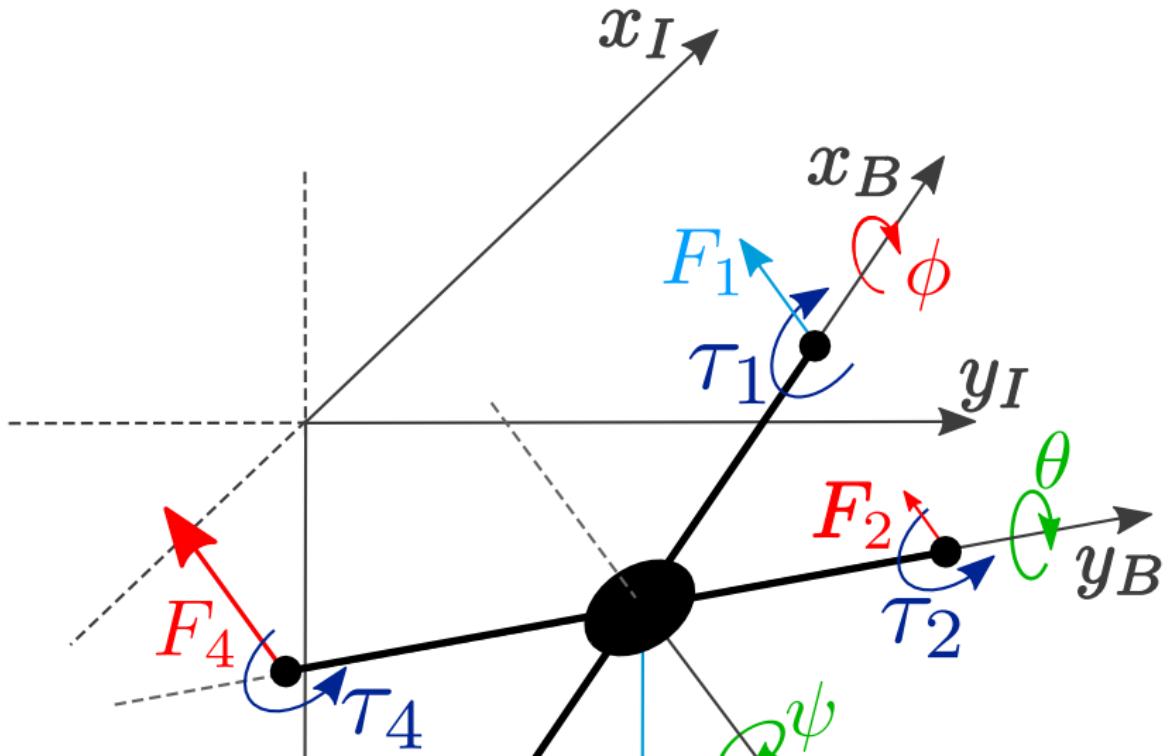
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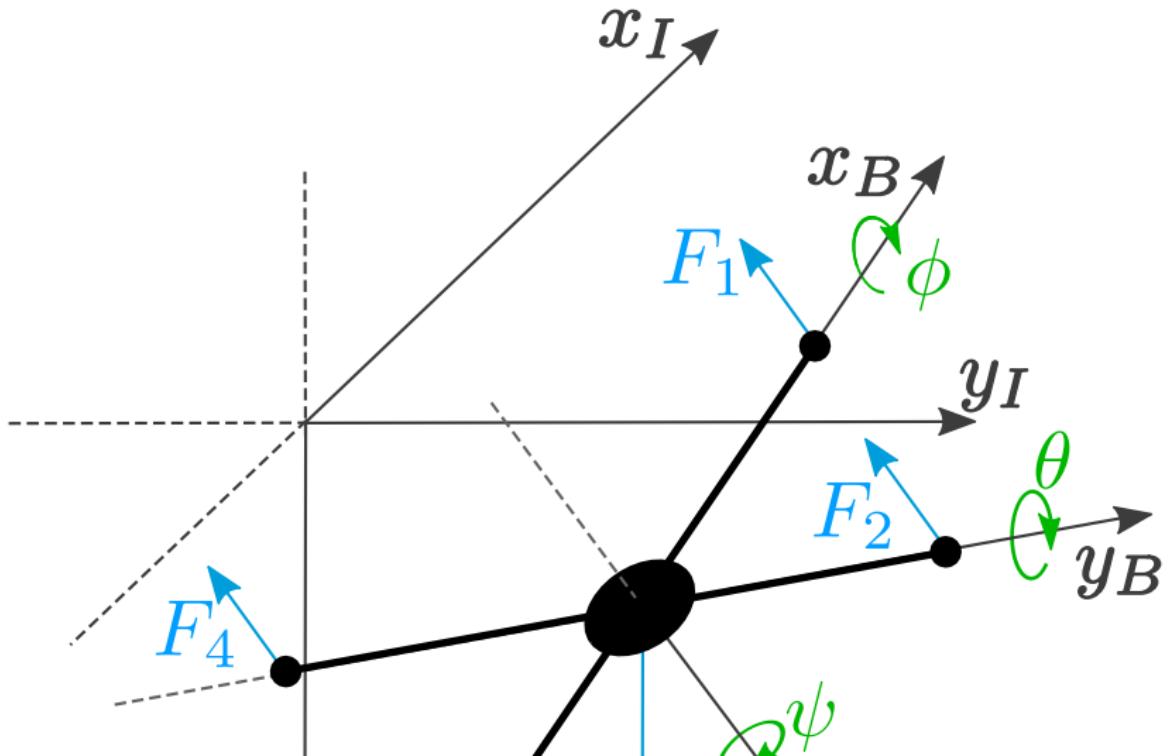
Model

Free Body Diagram



Model

Free Body Diagram



Translational Model



Something with rotation

Translational Model



equations

Linearization of the Model



Network

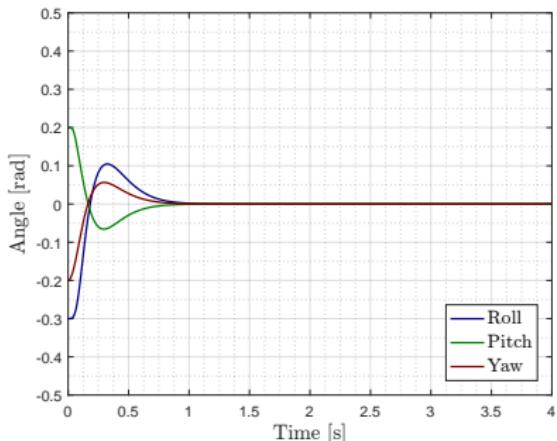


talk about protocol

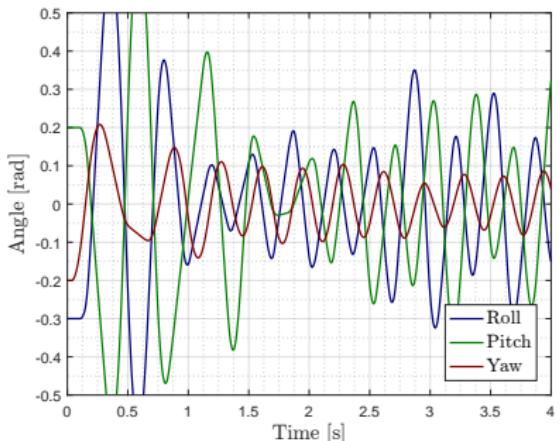
Network Main Issues



- ▶ Delay
- ▶ Missed packets



Control design only taking the model into account



Same controller with the effect of the network



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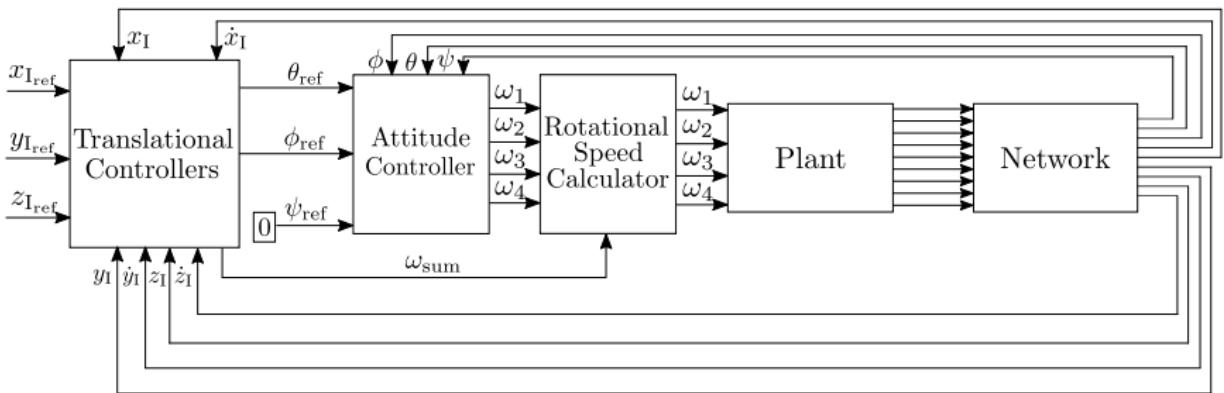
Translational Controller

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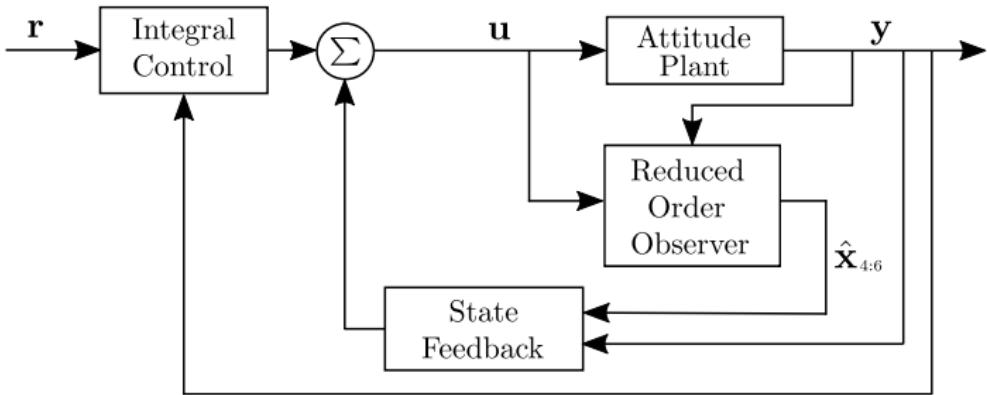
Conclusion

Control Solution



Control Solution

Attitude Controller



Control Solution

Attitude Controller



- System Representation

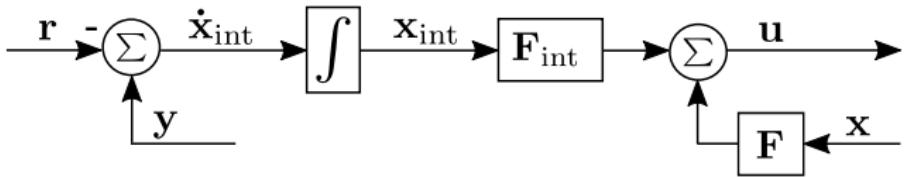
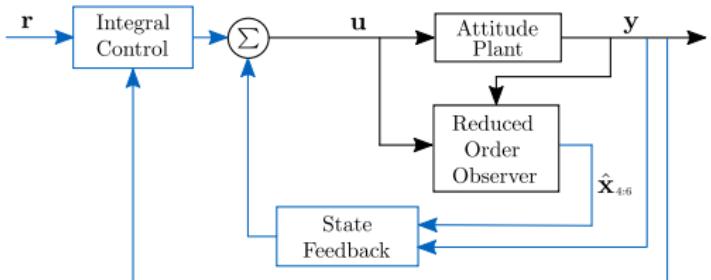
Control Solution

Attitude Controller



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- State Feedback with Integral Control



Control Solution

Attitude Controller



- LQR with Bryson's Rule

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

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

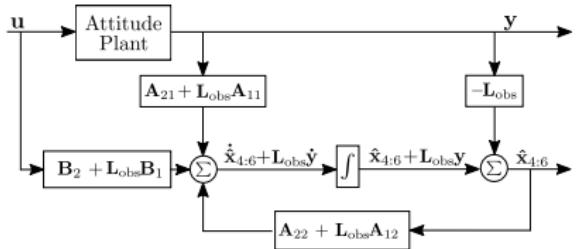
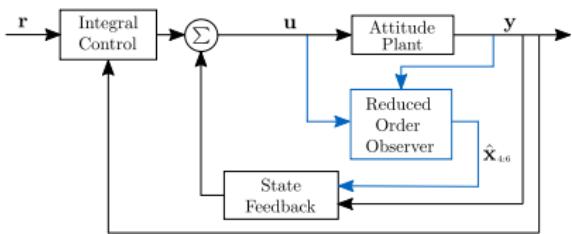
$$R_{ii} = \frac{1}{\text{maximum acceptable value of } [u_i^2]}$$

Control Solution

Attitude Controller



- Reduced Order Observer



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

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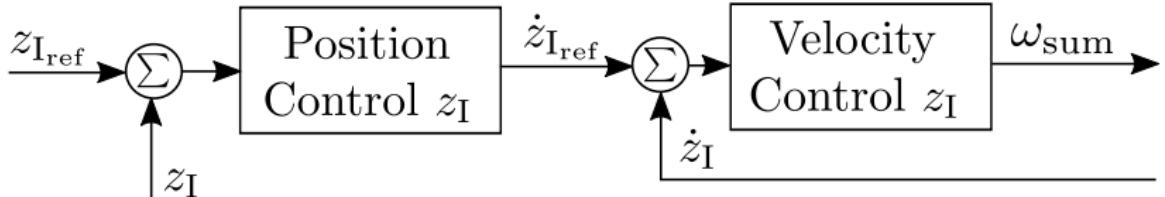
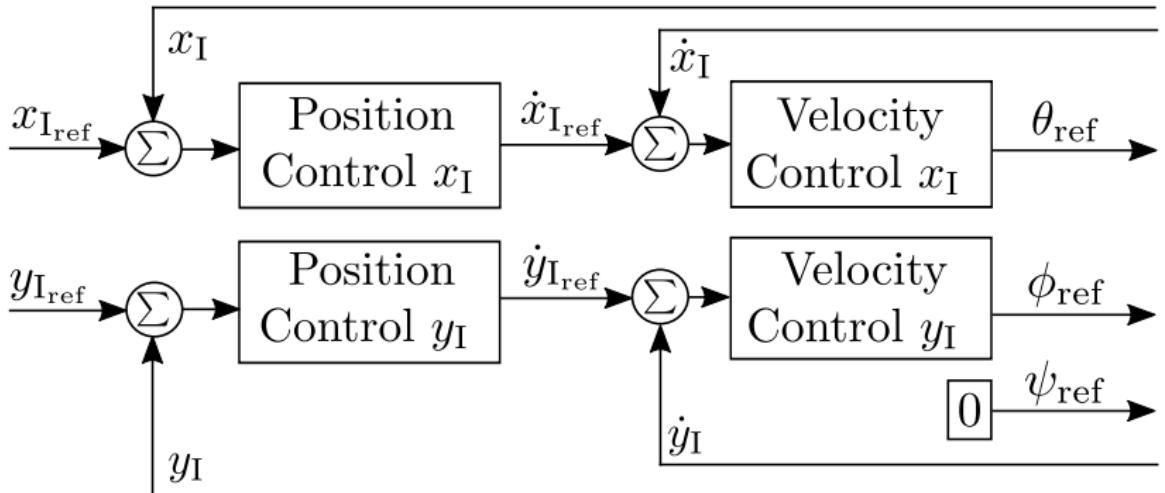
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Control Solution

Translational Controller



transfer functions with block diagram

Control Solution

Translational Controller



put three root locus

Control Solution

Translational Controller



consideration of bandwidth equations for velocity controllers
equations for position controllers

Implementation



FreeRTOS, tasks

Implementation Schedule



old 35ms

Implementation

Schedule



new, 25ms, less sampling freq.

Implementation Schedule



comparison oscilloscope

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Attitude Controller Simulations



Results

Translational Controllers Simulations



Results

Attitude Controller Functional Tests



Conclusion



- Similar to SEMCON
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