UCLA ENGINEERING

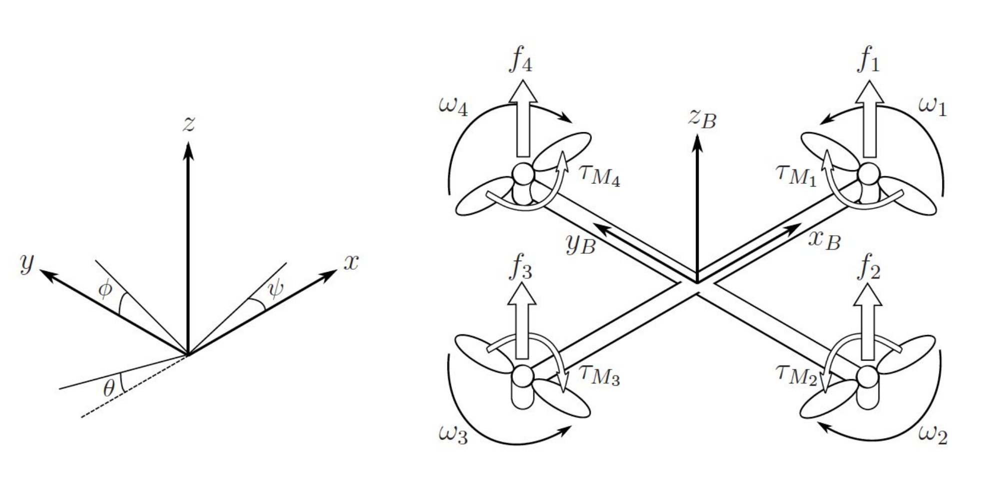
183 DB Weekly Report

Week1

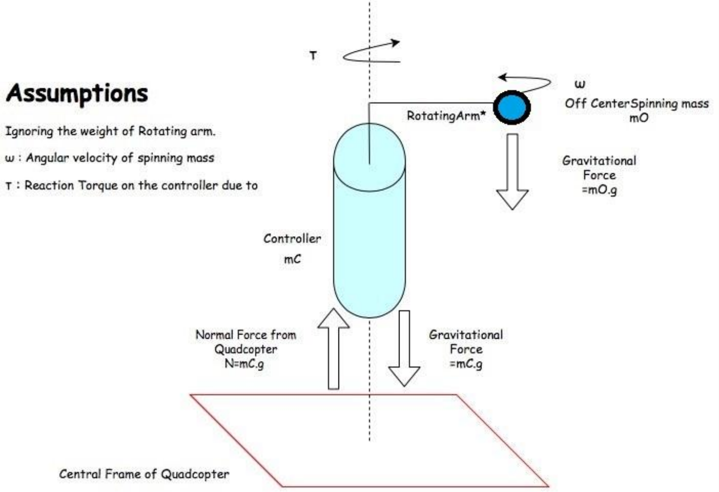
Team Parsley

Lin Li, Amir Omidfar, Wilson Chang, Angel ….

Free Body Diagrams

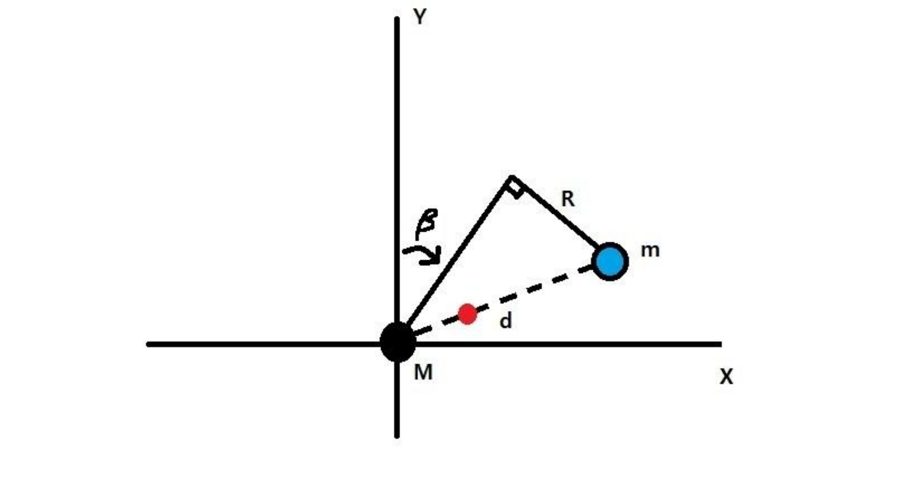


Quadcopter Free body Diagram [1]



Controller Free body Diagram

Mathematical Modeling



X: the horizontal axis

Y: the vertical axis

M: the mass of the quadcopter

m: the mass of the spinning object

R: the radius of the spinning object

d: the distance between the quadcopter and the spinning object

β: the pitching angle

g: the gravity constant (not shown on the figure)

Q: the ratio between the thrust and the gravity (not shown on the figure)

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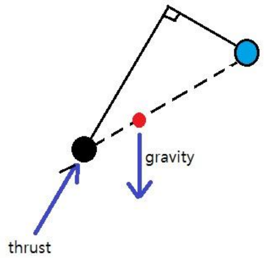
Mathematical Modeling

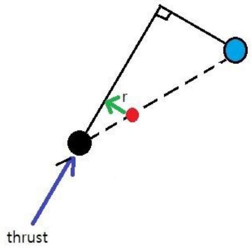


$$F_{\text{net}} = F_{\text{gravity}} + F_{\text{thrust}}$$

$$F_{\text{net}} = \begin{bmatrix}0\\-1\\0\end{bmatrix}(M+m)g + \begin{bmatrix}\sin\beta\\\cos\beta\\0\end{bmatrix}(M+m)gQ$$

<< The Net Force >>

$$Fnet = \begin{bmatrix}Q\sin\beta\\Q\cos\beta - 1\\0\end{bmatrix}(M+m)g$$



$$\text{Torque}_{\text{net}} = \text{r} \times \text{thrust}$$ (r cross product with the thrust)

$$\text{Torque}_{\text{net}} = \left\{\begin{bmatrix}\cos\beta\\-\sin\beta\\0\end{bmatrix}\frac{Rm}{M+m}\right\} \times \left\{\begin{bmatrix}\sin\beta\\\cos\beta\\0\end{bmatrix}(M+m)g\right\}$$

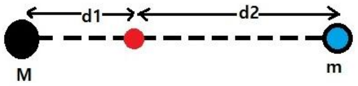
<< The Net Torque >>

$$Torque_{\text{net}} = \begin{bmatrix}0\\0\\1\end{bmatrix}RQmg$$

Mathematical Modeling

$$F_{\text{net}} = a(M+m)$$

$$Torque_{\text{net}} = bI$$



<< The Moment of Inertia >>

$$I = \frac{Mm}{M+m} d^2$$

<< The Translational Acceleration >>

$$a = \begin{bmatrix} Q\sin\beta \\ Q\cos\beta - 1 \\ 0 \end{bmatrix} g$$

<< The Rotational Acceleration >>

$$b = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \frac{RQg(M+m)}{Md^2}$$

Drone Specifications

Testing

```
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```

Getting yaw, roll and pitch measurements from the CF Client software

First CF flight test to make sure we use the resources to program and collect date from the drone using cf Client software:

https://youtu.be/7awN_Fga4PQ

Documentation

Abstract

Your abstract.

1 Symbols

Here is a list of all symbols used in this paper:

$\boldsymbol{\xi}$	linear position vectors
$\boldsymbol{\eta}$	angular position vectors
α	roll angle
β	pitch angle
γ	yaw angle
$\boldsymbol{V_B}$	linear velocity vectors in Body frame
$\boldsymbol{\nu_B}$	angular velocity vectors in Body frame
$\boldsymbol{R}$	rotation matrix from body to inertial frame
S_x, C_x, T_x	$\sin(x), \cos(x), \tan(x)$ respectively

2 Mathematical Derivation

2.1 Free Body Diagram

2.2 Inertial / Body / Controller frame transformation

The Rotation matrix is shown below,

$$\boldsymbol{R} = \begin{bmatrix} C_\gamma C_\beta & C_\gamma S_\beta S_\alpha - S_\alpha C_\alpha & C_\gamma S_\beta C_\alpha + S_\gamma S_\alpha \\ S_\gamma C_\beta & S_\beta S_\theta S_\alpha + C_{\gamma]} C_\alpha & S_\gamma S_\beta C_{alpha} - C_\gamma S_\alpha \\ -S_\beta & C_\beta S_\alpha & C_\beta C_\alpha \end{bmatrix}$$

2.3 Newton-Euler equations

$$m\dot{\boldsymbol{V}}_B + \boldsymbol{\xi}_B \times (m\boldsymbol{V_B}) = \boldsymbol{R}^T \boldsymbol{G} + \boldsymbol{T}_B$$

References

1. T. Luukkonen, "Modelling and control of quadcopter," *Aalto School of Science*, Aug. 2011.