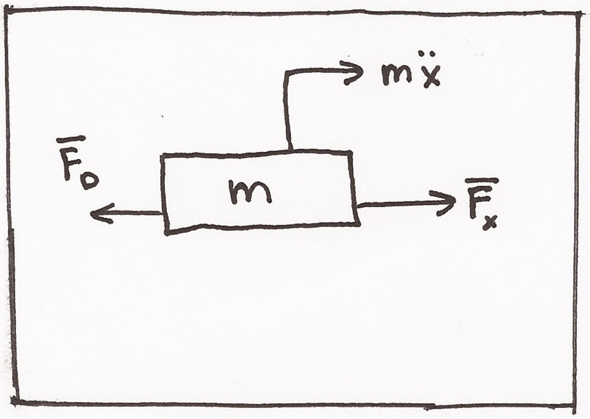
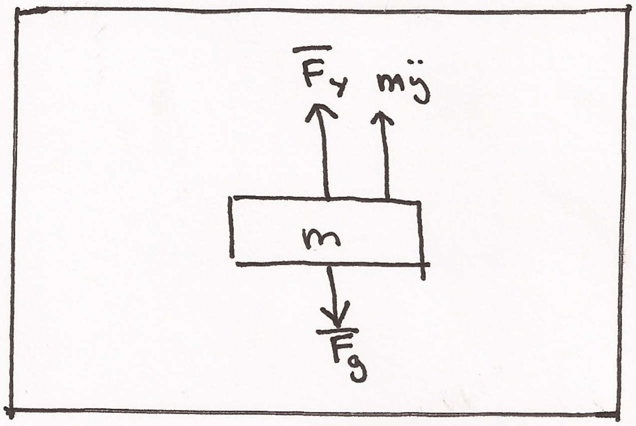
Dynamical Equations

Clay McCleod
Control Systems



Horizontal Forces
Side View



Vertical Forces
Side View

where $\bar{F}$ is some predictable force applied by our thrusters.
$\bar{F}_D$ is the drag due to air resistance.
$\bar{F}_g$ is the force from gravity.

equation for drag is $\bar{F}_D = \frac{1}{2} \rho \dot{x}^2 C_D A$

where

$\rho = 287.058\ J/kg \cdot K$ or $1.1839\ kg/m^{-3}$ at $77°F$

$\dot{x}^2 =$ velocity squared

$a = 1.75\ ft \times 1.25\ ft = 2.1875\ ft^2 = 0.2\ m^2$

$C_D =$ similar to a model rocket at 0.75

<u>so</u>

$$\bar{F}_D = 0.089\, \dot{x}^2\ N$$

$$F_g = 9.8 \cdot m\ N$$

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Dynamical Equations cont.

horizontal

$m\ddot{x} = \bar{F}_D - \bar{F}_x$

$m\ddot{x} + \bar{F}_x - 0.089\dot{x}^2 = 0$

vertical

$\bar{F}_y + m\ddot{y} = m \cdot 9.8$

$m\ddot{y} + \bar{F}_y - m(9.8) = 0$

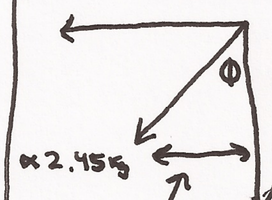
but $\bar{F} = 2.45 \cdot \alpha$ where α is some number from 0 to 1 to describe how much power is being

and m = mass of craft = 4.074 Kg.

so

ϕ = tilt of fan as described here

Force from fan



$f_x \Rightarrow \sin\phi = \frac{f_x}{\alpha 2.455}$

$\alpha 2.455 \sin\phi = f_x$

$\cos\phi = \frac{f_y}{\alpha 2.455}$

$f_y = \alpha 2.455 \cos\phi$

horizontal

$4.074\ddot{x} + \alpha 2.455\sin\phi - 0.089\dot{x}^2 = 0$

Vertical

$4.074\ddot{y} + \alpha 2.455\cos\phi - (4.074)9.8 = 0$

So final dynamical equations:

(1) $\ddot{x} + \boxed{\alpha} 0.602\sin\phi - 0.022\dot{x}^2 = 0 \Rightarrow \boxed{\ddot{x} - 0.22\dot{x}^2 + (\alpha)0.602\sin\phi}$

(2) $\boxed{\ddot{y} + \alpha 0.602\cos\phi - 9.8 = 0}$

where α equals power to fans coefficient (adjustable constant)

and ϕ is the angle of fans (adjustable constant)