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ME-457

HW 1

1. Remo-001-M

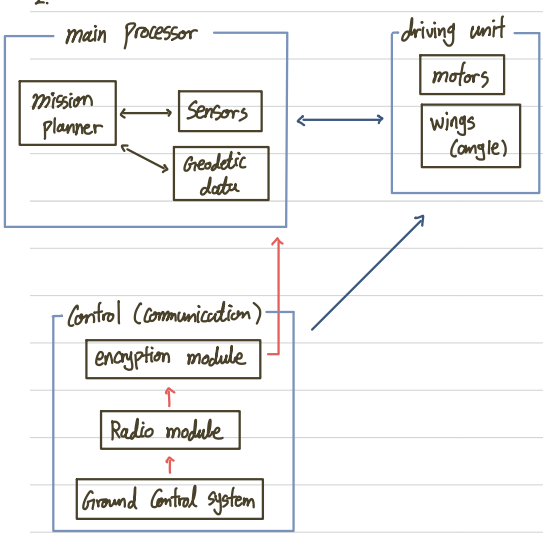
- wing-span : 4.29ft
- overall length : 0.65m
- max speed : 80kph
- operation range : 8km

Remo-m steered similarly with Conventional airplanes. Steering is achieved using Control Surfaces such as Ailerons (for roll), Elevator (for pitch) and Rudder (for yaw)

The Maestro Flight management system handles autonomous flight, while Control handset allows for manual operation when needed

Coordinated turn is a maneuver that is used to balance combination of ailerons, elevator and Rudder to smoothly change direction without sideways slip or skid

2.



Block diagram is useful when understanding how the UAV works step-by-step and how different "blocks" interact with each other.

3.

First, most of the UAV that are used in real life operations are very expensive. Since they are costly, it should minimize risks and double check every aspects. Also, with simulation, different function can be tested without any risk.

4.

a) battery related to COM in body-frame = (0.2, 0, 0)

$\psi = 2^\circ \quad \theta = 10^\circ \quad \varphi = 20^\circ$

$$R_v^b = R_{v_2}^b(\psi) R_{v_1}^{v_2}(\theta) R_v^{v_1}(\varphi)$$

$$= \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos 20^\circ & \sin 20^\circ \\ 0 & -\sin 20^\circ & \cos 20^\circ \end{pmatrix} \begin{pmatrix} \cos 10^\circ & 0 & -\sin 10^\circ \\ 0 & 1 & 0 \\ \sin 10^\circ & 0 & \cos 10^\circ \end{pmatrix} \begin{pmatrix} \cos 2^\circ & \sin 2^\circ & 0 \\ -\sin 2^\circ & \cos 2^\circ & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$p_{com}^b = R_v^b(\psi,\theta,\varphi)^T p^v = R_v^b(0.2, 0, 0)$$

$$= (.197, .00687, -.035)\ m$$

$$p_{battery} = p^{com} + p_{com}^b = (0.197, 0.00687, -0.035) + (0, 0, -10)$$

$$= (0.197, 0.00687, -10.035)\ m$$

b)

$$V_b = (15, 1, 0.5)\ m/s$$

$$V_e = R_v^b(\psi,\theta,\varphi)^T V_b = R_v^b(15, 1, 0.5)$$

$$= (14.88, 1.29, -1.81)\ m/s$$

c)

$$\gamma = \tan^{-1}\left(\frac{-1.81}{\sqrt{14.88^2 + 1.29^2}}\right) = -6.91^\circ$$

d)

$$\alpha = \cos^{-1}\left(\frac{15}{\sqrt{15^2 + .5^2}}\right) = 1.91^\circ$$

e)

Heading angle is angle between where aircraft is pointing and the true north.

Course angle is the angle between the direction in which the aircraft is actually moving above the ground and the true north.

5.

a) Program integrates the state vector with euler's method, which is one of the numerical integration method. The plotted system shows x and y values of state vector over the time interval.

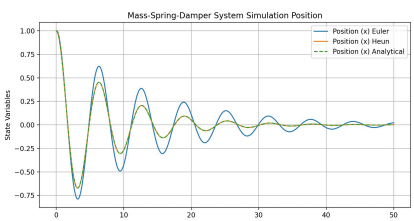
b)

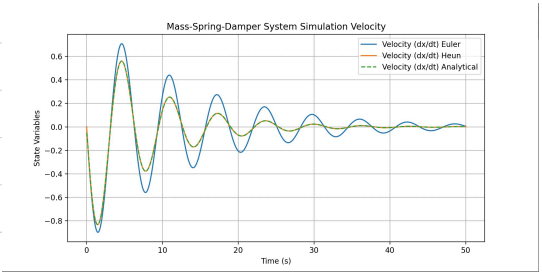
$$m\ddot{x} + b\dot{x} + kx = 0 \quad \rightsquigarrow \quad \ddot{x} = -\frac{b}{m}\dot{x} - \frac{k}{m}x$$

let $x_1 = x \quad x_2 = \dot{x}$

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} x_2 \\ -\frac{b}{m}x_2 - \frac{k}{m}x_1 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -\frac{k}{m} & -\frac{b}{m} \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

$$s_{1,2} = -\frac{b}{2m} \pm \sqrt{\left(\frac{b}{2m}\right)^2 - \frac{k}{m}} = -\frac{b}{2m} \pm i\sqrt{\frac{k}{m} - \left(\frac{b}{2m}\right)^2}$$





c)