

1 Definiendo los estados

$$X = \begin{bmatrix} roll \\ roll \\ pitch \\ yaw \\ roll \\ pitch \\ yaw \\ x \\ y \\ z \\ \dot{x} \\ \dot{y} \\ \dot{z} \end{bmatrix} = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \\ x_8 \\ x_9 \\ x_{10} \\ x_{11} \\ x_{12} \end{bmatrix}$$

$$U = \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ u_4 \end{bmatrix}$$

2 Ecuaciones de la dinamica

$$\begin{aligned} \ddot{roll} &= 10 * U_1 - 0.77 * pitch * yaw \\ \ddot{pitch} &= 10 * U_2 + 0.78 * \dot{roll} * yaw \\ \ddot{yaw} &= 5.8 * U_3 - 0.011 * pitch * \dot{roll}; \\ \ddot{x} &= 0.29 * U_4 * (\sin(roll) * \sin(yaw) + \cos(roll) * \cos(yaw) * \sin(pitch)); \\ \ddot{y} &= -0.29 * U_4 * (\cos(yaw) * \sin(roll) - 1.0 * \cos(roll) * \sin(pitch) * \sin(yaw)); \\ \ddot{z} &= 0.29 * U_4 * \cos(pitch) * \cos(roll) - 9.8; \end{aligned}$$

3 Espacio estados final

$$\begin{aligned} \dot{x}_1 &= x_4 \\ \dot{x}_2 &= x_5 \\ \dot{x}_3 &= x_6 \\ \dot{x}_4 &= 10 * U_1 - 0.77 * x_5 * x_6 \\ \dot{x}_5 &= 10 * U_2 + 0.78 * x_4 * x_6; \\ \dot{x}_6 &= 5.8 * U_3 - 0.011 * x_5 * x_4; \\ \dot{x}_7 &= x_{10} \\ \dot{x}_8 &= x_{11} \\ \dot{x}_9 &= x_{12} \\ \dot{x}_{10} &= 0.29 * U_4 * (\sin(x_1) * \sin(x_3) + \cos(x_1) * \cos(yaw) * \sin(x_2)); \\ \dot{x}_{11} &= -0.29 * U_4 * (\cos(x_3) * \sin(x_1) - 1.0 * \cos(x_1) * \sin(x_2) * \sin(yaw)); \\ \dot{x}_{12} &= 0.29 * U_4 * \cos(x_2) * \cos(x_1) - 9.8; \end{aligned}$$

$$\begin{aligned} \dot{y}_1 &= x_1 \\ \dot{y}_2 &= x_2 \\ \dot{y}_3 &= x_3 \\ \dot{y}_4 &= x_9 \end{aligned}$$