

States:

In order to localize the quadrotor and control its movement, a pose and its derivatives are needed. Also the angular speeds of the motors are considered as a state to control its performance when the rate are increased or decreased:

X1: X position of the system in a fixed reference.

X2: Y position of the system in a fixed reference.

X3: Z position of the system in a fixed reference.

X4: Pitch of the system in a body reference.

X5: Roll of the system in a body reference.

X6: Yaw of the system in a body reference.

X7: dx/dt of the system in a fixed reference.

X8: dy/dt of the system in a fixed reference.

X9: dz/dt of the system in a fixed reference.

X10: Angular rate of the system around x-axis of a fixed reference.

X11: Angular rate of the system around y-axis of a fixed reference.

X12: Angular rate of the system around z-axis of a fixed reference.

X13: Angular rate of first motor of the system.

X14: Angular rate of second motor of the system.

X15: Angular rate of third motor of the system.

X16: Angular rate of fourth motor of the system.

Control Signals:

The variations of the angular velocity of each motor are chosen as a control signals:

U1: Variation of angular velocity of first motor.

U2: Variation of angular velocity of second motor.

U3: Variation of angular velocity of third motor.

U4: Variation of angular velocity of fourth motor.

System Model:

The system model of our case of study consists of a mathematical quadrotor model after applying some simplifications. Also a mathematical model of an arm is going to be coupled to the UAV and it will be used as a disturbance of the system.

//Imágenes del sistema

Plant:

During the simulation, a more complex system of the quadrotor is going to be used in order to be closer of the real behaviour.

//Imágenes del sistema complejo

MPC Controller:

* Dynamic Optimizer: A solver that given a cost function, constraints and a dynamic system, find the best control signals that minimize the cost function and respects all the constraints.
* Cost Function + Constraints: Cost function is the target to minimize. Constraints are limit of the state space, the control signals and the physics limitations.

Cost Function

J = (X1 – r1)^2 + (X2 – r2)^2 + (X3 – r3)^2

r : Reference. Position in the space.

State - Constraints:

-100 < X1 < 100 -0.1 < X4 < 0.1 -1 < X7 < 1 -1 < X10 < 1

-100 < X2 < 100 -0.1 < X5 < 0.1 -1 < X8 < 1 -1 < X11 < 1

-100 < X3 < 100 -0.1 < X6 < 0.1 -10 < X9 < 10 -1 < X12 < 1

200 < X13 < 1000 -1000 < X14 < -200 200 < X15 < 1000 -1000 < X16 < -200

Control Signal – Constraints:

-100 < U1 < 100 -100 < U2 < 100 -100 < U3 < 100 -100 < U4 < 100