Behavior-based Leader-follower Formation Control for Multi UAVs

# The UAV kinematic

Assume that a swarm of UAV has agent. Denote is the position of the UAV. The kinematic model of the UAV is given as follow.

where is the control signal where is the linear velocity along x axis of the UAV body frame, and are the pitch ans yaw angle of the UAV, respectively.

# Behavior-based control for the leader UAV

## Move to goal.

Denote is the position of the leader UAV in the formation. Denote is the desired reference of the leader. The alignment velocity is represented as.

## Obstacles avoiding

The obstacles is represented by the cylinder which described by the obstacle position, and obstacle radius, .

Assume is the sensing radius of the UAV. Denote is the distance from the leader UAV to the obstacle and is given as.

The obstacle avoiding velocity is represented as.

# Behavior-based control for the follower UAV

## Follow its leader

Denote is the position of the follower UAV and is it leader UAV. Assuming that the follower UAV is in the leader UAV frame.Therefore, the follower’s position must satisfy.

Thus, the alignment velocity of the follower is represented as.

## Separation

Except is leader, the follower UAV need to avoid collision with other UAV.

## Obstacles avoiding

Behavior design

1. Behavior of moving to goal

Assume that the current position of the UAV is and the desired position is . Denote is the distance from the UAV and the desired position (1)

Thus, the behavior vector of moving to the goal is (2)

The controlling parameter of the behavior is defined as (3)

where and are the adjustment parameters.

1. Behavior of avoiding obstacle

Assume that the obstacle is represented by a cylinder with the position is , the obstacle radius is and the height is . Denote is the distance between UAV and the obstacle (4)

Thus, the vector of avoiding obstacle is (5)

The sign is determined by the relation ship between the moving direction of the robot and the obstacles. When the obstacles are on the left, set it positive, and if the obstacle is on the right, set it negative. The control parameter is defined as (6)

1. Behavior of avoiding robot

The vector of the behavior of avoiding robot is (3)

1. Behavior of keeping formation

Assume the ideal relationship between the UAV and UAV is . Thus, the ideal position of the UAV is (4)

Therefore, the behavior of keeping formation is (5).

1. The overall behavior vector

The overall vector is sum of subbehavior and is defined as (6).