A Bio-inspired Collision Detector & Its Application on small Quadcopter

University of Lincoln

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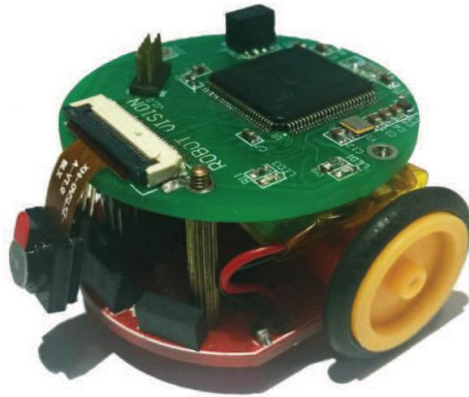
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LINCOLN

Mobile Robot

Collision detector

Quadcopter

Detector on the Quadcopter

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Background

About LGMD

About Quadcopter
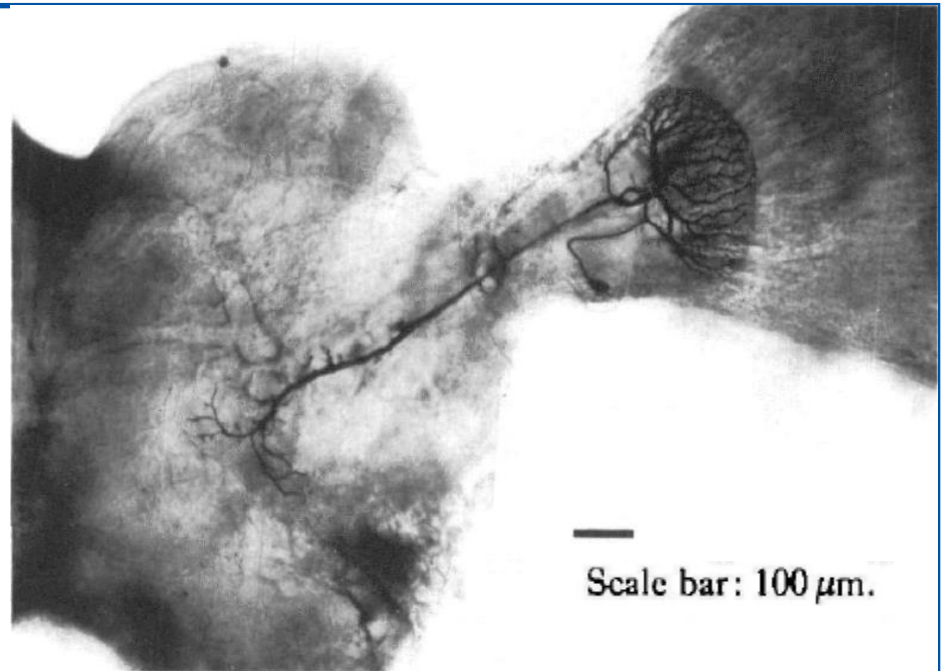
LGMD

Lobula Giant Motioin Detector

Origin

Scale bar: 100 μm.

Character: Responds to imminent collision & approaching predetors

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LGMD

Lobula Giant Motioin Detector

Features

1   25-30ms delay to response a collision

2   More sensitive to approaching Obstacles than complex background

3   Direction selectivity
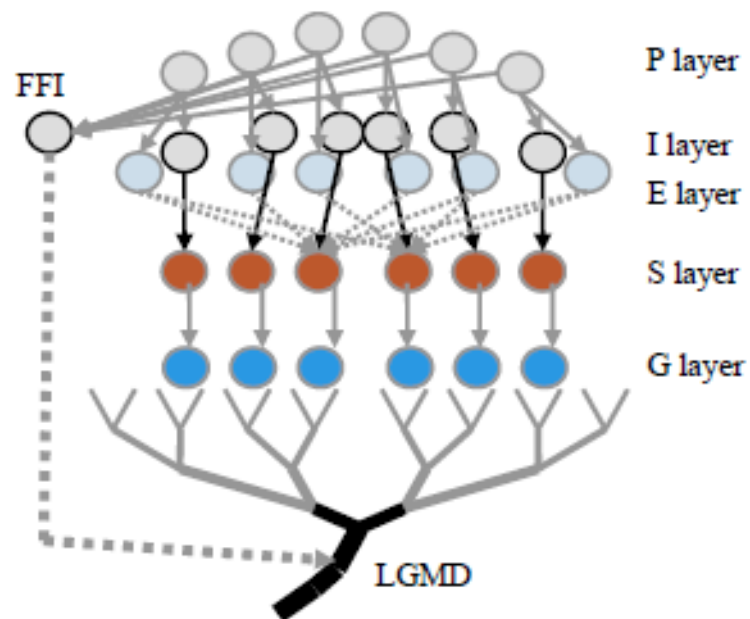(not realized on artificial components)

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LGMD

5 functional layers of the LGMD

Structure
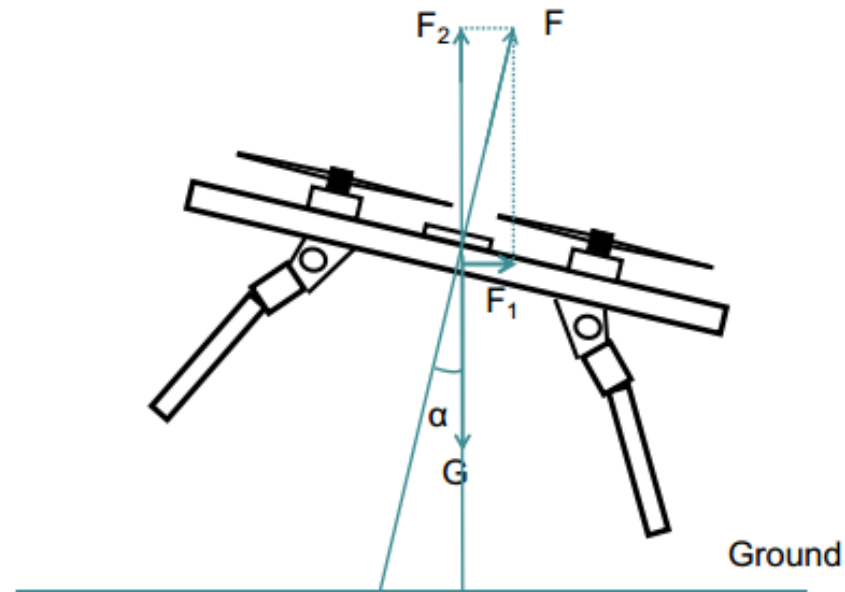
Quadcopter

6 Degree of Freedom

Quadcopter

**Current avoiding method for UAV： SLAM
（ computationally intensive ）**

**Main Character:
Lateral Inhibition**

$$P_f(x,y) = L_f(x,y) - L_{f-1}(x,y)$$

(1)

$$E_f(x,y) = P_f(x,y)$$

(2)

$$I_f(x,y) = \sum_{i=-r}^{r}\sum_{j=-r}^{r} P_{f-1}((x+i),(y+j)) \cdot W(i,j), \ (\text{if } i=j, j \neq 0)$$

(3)

**Main Character:
Lateral Inhibition**

$$G_f(x,y) = S_f(x,y)Ce_f(x,y)\omega^{-1} \tag{4}$$

$$[Ce]_f = [S]_f \otimes [\omega_e] \tag{5}$$

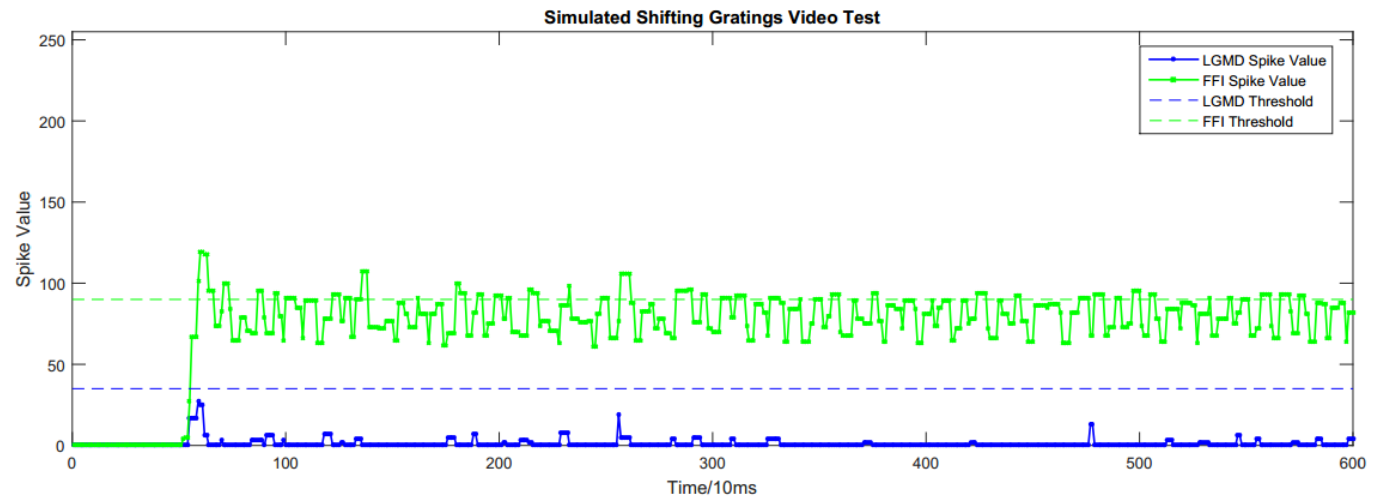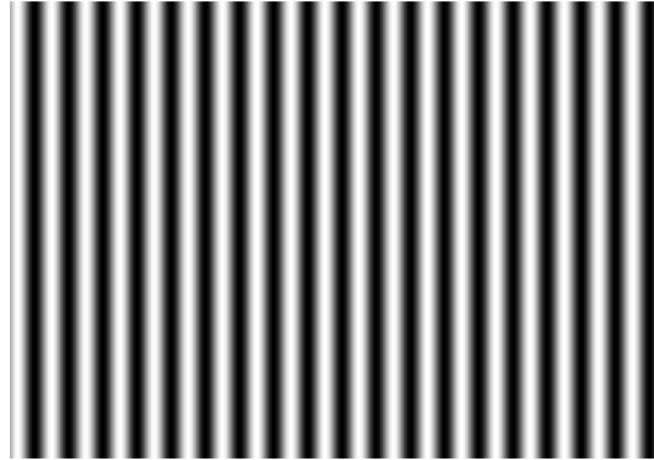$$[\omega_e] = \frac{1}{9}\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \tag{6}$$

Response to Lateral Shifting Video Simulation

Simulated Shifting Gratings Video Test
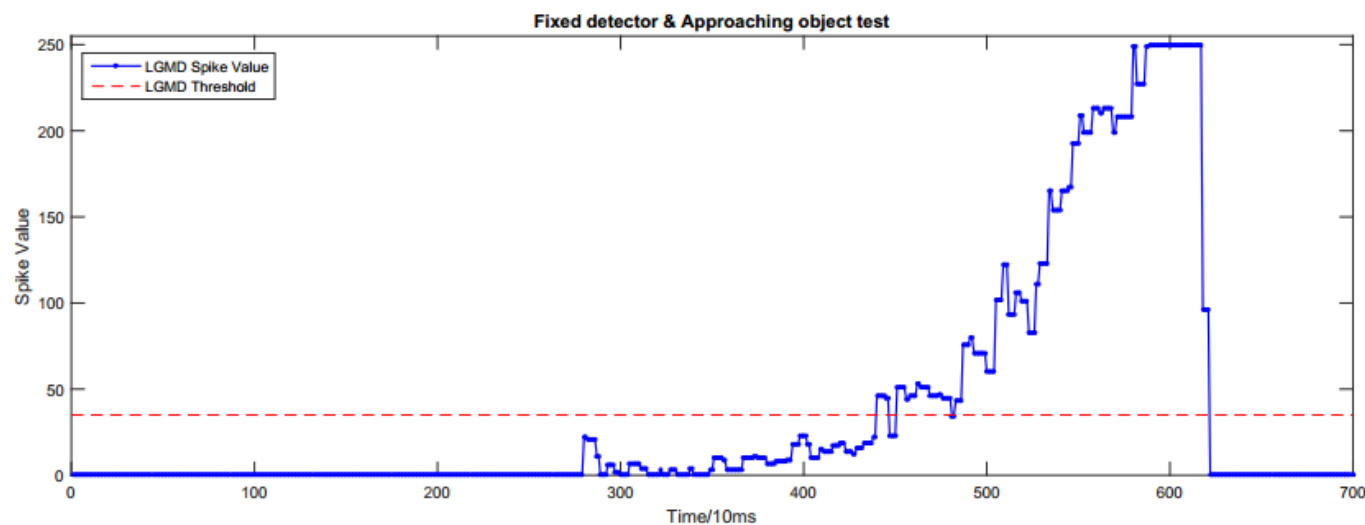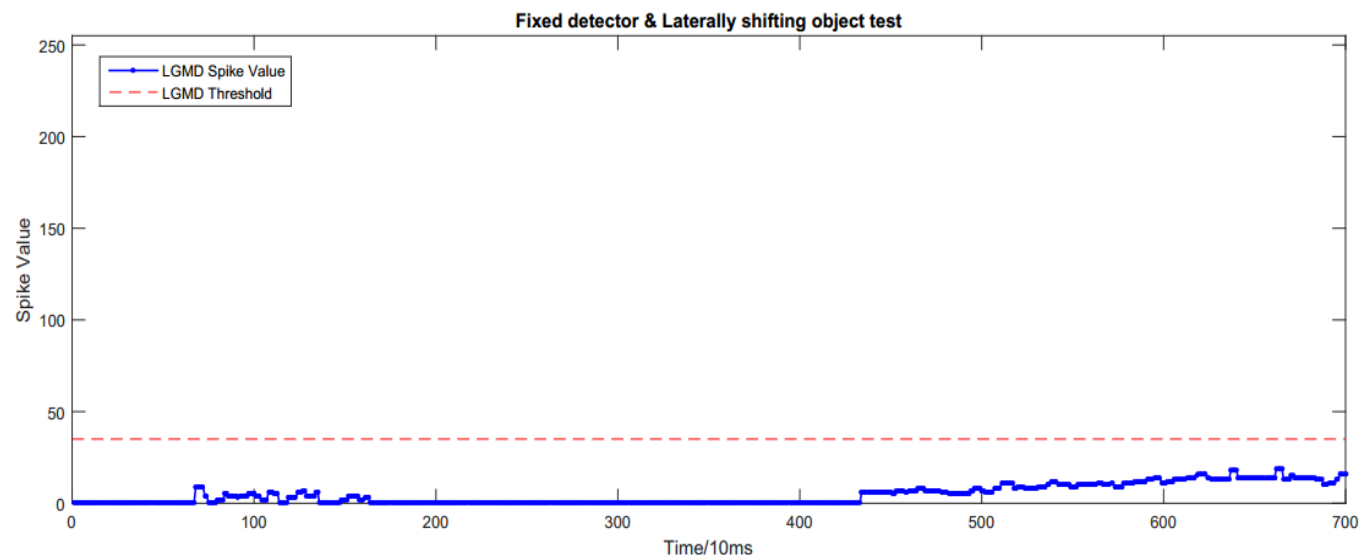
(d) Result of approaching objects test.

Modules
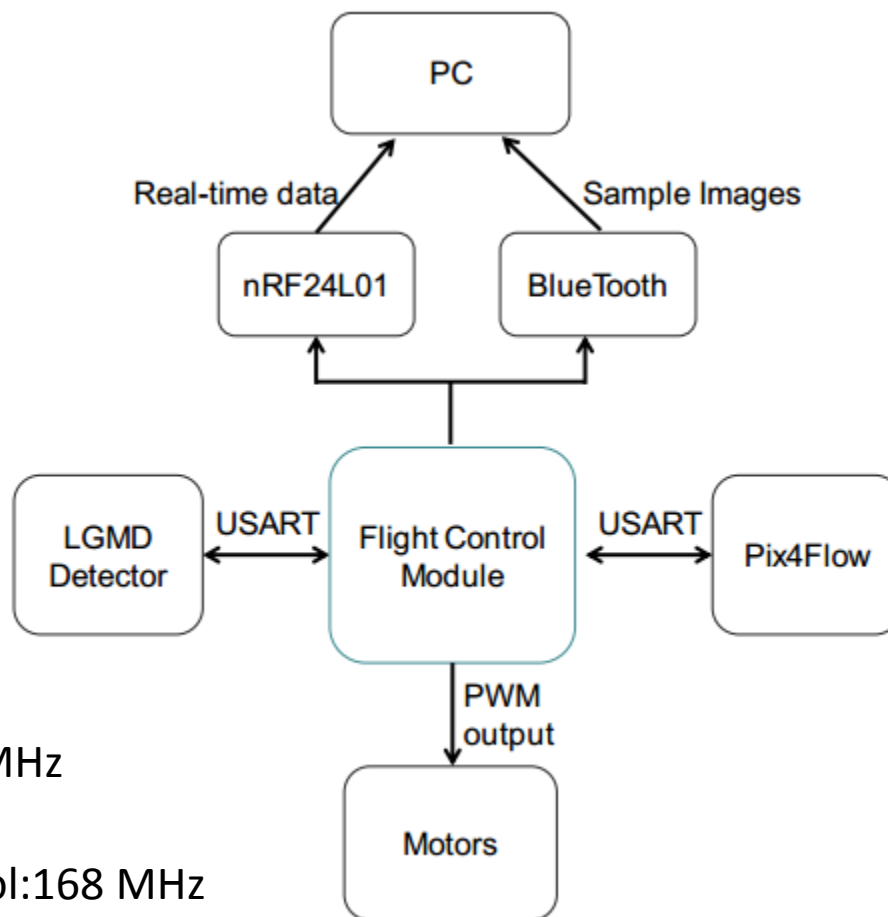
LGMD:168 MHz

Flight Control:168 MHz

Control Mechanism

Control Mechanism

Cruise

Cruise Task

Optic flow speed in x Axis

Avoiding Task

Optic flow speed in y Axis

Slow-down Task

Optic flow speed in current Axis

$(C_f^{LGMD} = 1) \& \&(C_f$

$C_f = 1$
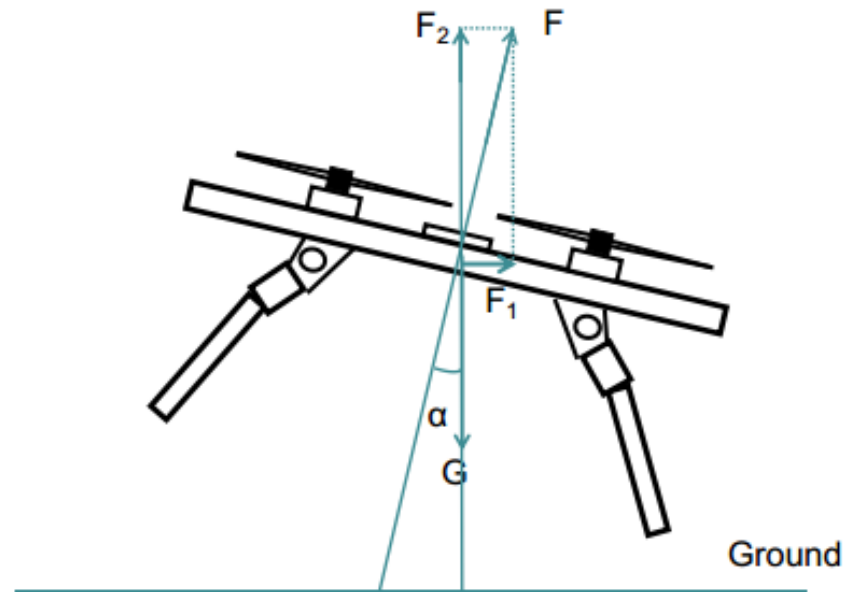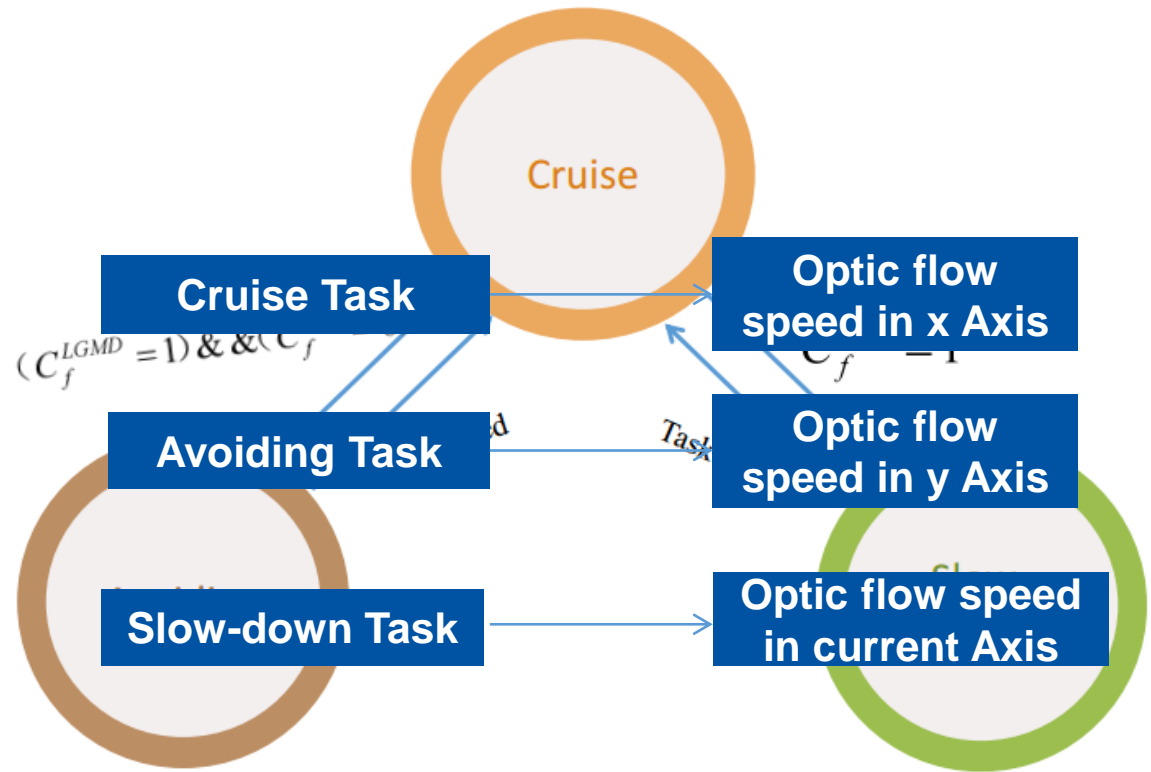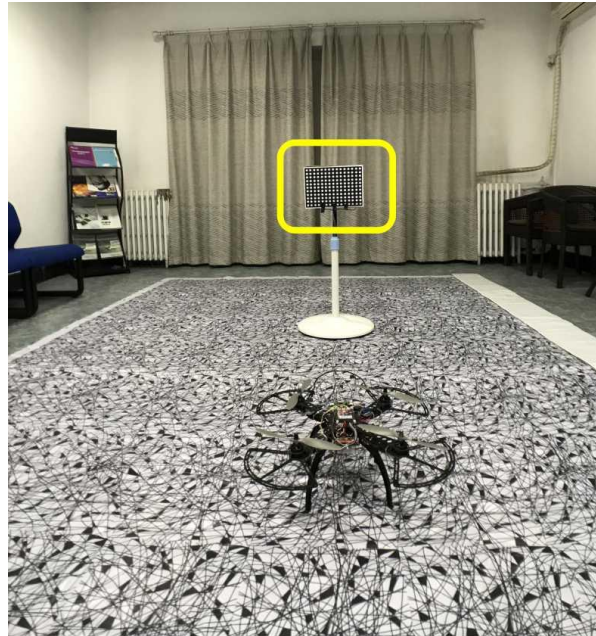
Avoiding Tests

A glimpse of the arena
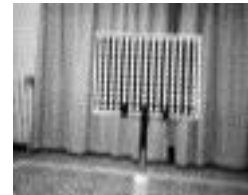
Image from the Detector

99*72 Pixels/ frame
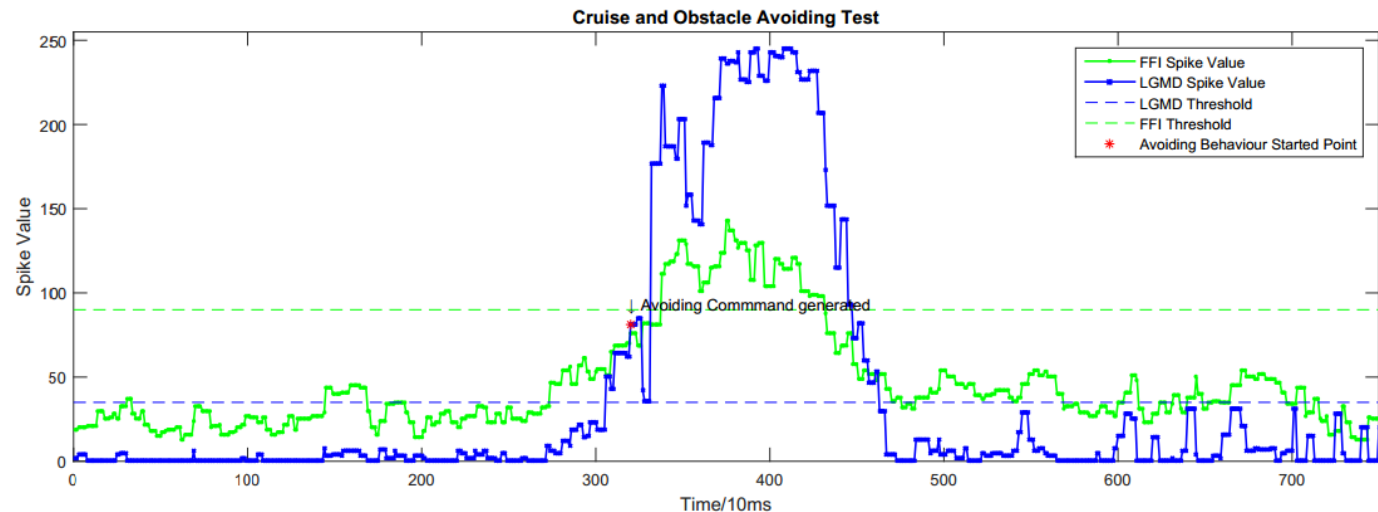
Avoiding Tests

Spiking Results in avoiding test

Avoiding Tests
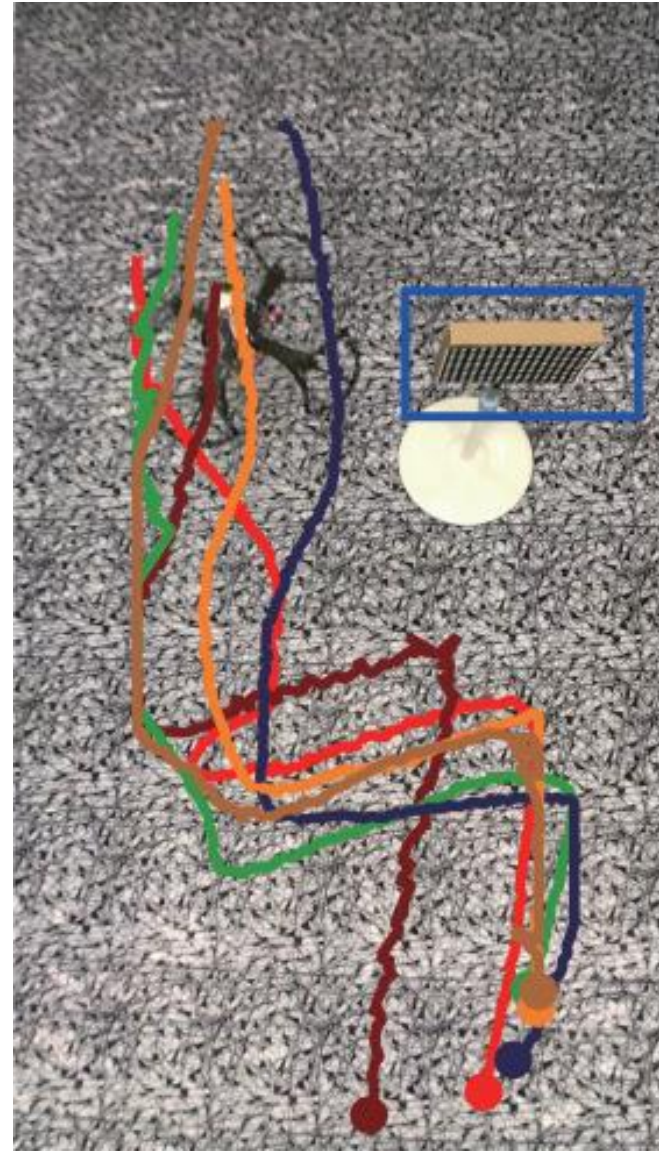
Trajectory in overlook view scene

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Further discussion

Make the quadcopter more intellegent

Develop the neuron network in deepth