DRONE CHALLENGE

DEMOS

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1 Introduction

1.1 Purpose

In this document will be presented the first four demos concerning the Drone Challenge of 2021 edition, held by the Uppsala University in Sweden.

In those demos will be tested some specific behaviour of the Crazyflie drones, which it has been selected by us in order to gather some possible behaviour of this type of drone.

1.2 Components used

In this section will be presented the different components that are going to be used in the scope of the presented demos:

- **Crazyflie drone 2.X** (Website): is the type of drone used for the demos.
- **Lighthouse positioning System** (Website): is the method of positioning used to test the demos presented. It is composed by:
  - Two lighthouse base stations that emit infrared laser.
  - One lighthouse positioning deck, mounted on the drone to receive the infrared laser and calculate its own position.

1.3 Decks used

A deck is an upgrade of the drone that allows it to do more sophisticated actions. In the scope of the demos presented, the different decks used are:

- **Lighthouse positioning deck** (Website): is a deck that gives the drone the ability to calculate its own position in the Lighthouse system.
- **Multi-ranger deck** (Website): is a deck that gives the drone the ability to detect the objects around it (on the X and the Y axis).
- **Z-ranger deck v2** (Website): is a deck that gives the drone the ability to detect the objects below and above it (on the Z axis).
- **Flow deck v2** (Website): is a deck that gives the drone the ability to understand better when its moving in any direction.

Except for the stability improvements, the Z-ranger deck and the Flow deck works in similar way, so for the scope of those demos we will just use the Z-ranger deck.

1.4 Reference document

- Uppsala University Drone Challenge 2020 (PDF)
- Drone Area - Demonstrator Projects (PDF)
- CrazyFlie Documentation https://github.com/bitcraze/crazyflie-lib-python

2 Workspace

The demos have been carried out at Politecnico of Milan in the NesLab.

Since the Crazyflie has no real notion of its position in space, the Lighthouse positioning system is being used. This system covers a cubic area in which we let the drone flies with size 5[m] X 5[m] X 2[m].

Since the library is written in Python, the demos are written in the same programming language.

In the scope of this challenge the drones could be upgraded with a maximum of 4 decks, but we will never use more than 3 decks in the challenge presented below.

For every demos implemented, the MotionCommander is being used to control the movement of the drones, along with the logging provided by the different decks.

Unluckily the Z-ranger deck v2, seems to have problem while passing above an object. To be more precise it lost its stability for 1 second because of the compensation on the Kalman Filter.

3 Demos

3.1 First demo - Zig-zag between objects

The first demo presented will use the following decks:

- Lighthouse positioning deck
- Multi-ranger deck

In this demo the drone will start moving in linear motion, until it reaches an obstacle. Thanks to the logging values retrieved by the Multi-ranger, it will detect that is too close to that object so it will try to rotate 90° clockwise and it will try to proceed.

If no obstacle is immediately present it will continue straight forward, otherwise, instead of rotate clockwise, it will rotate 90° counterclockwise and will try to proceed.

If this time no obstacle is immediately present it will continue forward, until another obstacle is found and the algorithm will restart from the beginning, otherwise it means that the drone has reached a dead end, the algorithm ends and the drone will lands.

3.2 Second demo - Overcome of an object

The second demo presented will use the following decks:

- Lighthouse positioning deck
- Multi-ranger deck
- Z-ranger deck v2

In this demo the drone will start moving in linear motion, until it reaches an obstacle. Thanks to the logging values retrieved by the Multi-ranger, it will detect that is too close to that object so it will try overcome it.

So, using to the logging values of the Z-ranger and Multi-ranger decks mixed together, it will increase its Z-position until the obstacle in front of him it is no more present; at that time it starts moving forward until the obstacle is surpassed.

The drone will recognize that the obstacle is overcomed, using the logging values of the Z-ranger deck, so it will immediately starts going down at a certain height to proceed its path.

3.3 Third demo - Pass on the left

The third demo presented will use the following decks:

- Lighthouse positioning deck
- Multi-ranger deck

This demo is quite similar to the previous one, starting moving in linear motion it continues until an obstacle is detected. Thanks to the logging variable received from the Multi-ranger, it will detect that is too close to that object so it start to moving left while the obstacle is present.

When the object isn't detected anymore on the front, it can start moving alongside to it until the drone will overtake the obstacle. At this point, using previously saved y values, it can move again in the same path it was following before the obstacle detection.

3.4 Fourth demo - Follow the human

The fourth demo presented will use the following decks:

- Lighthouse positioning deck
- Multi-ranger deck

At the beginning of this demo the drone will only land and increase its Z-position to a predetermined height.

At a certain point the drone will detect an obstacle to close to the front sensor of the Multi-ranger deck and from that moment the drone will start to follow that obstacle, remaining at a certain distance from it (in this context the obstacle detected is an hand).

In order to ends the program and let the drone lands, the hand must be put in the back of the drone.