Motion planning of a fixed wings Uav through an hybrid approach based on artificial potential fields and RRT.

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May 18, 2018

I. Introduction

We will present a work made for an international challenge[1] that every year involves several accademic teams.
This report respects the following structure :
in section II, we will present the problem statement and in section III we will give tecnical informations on the hardware at our disposal, finally in section IV, the adopted solution will be discussed.

II. Problem Statement

All the joining teams to the challenge will have to compete on several tasks concerning on actual problems in the governance of Unmanned Aerial Vehicles.
Each team will bring its prototype of UAV on a common flight ground and try to score the greatest number of points among all the tasks proposed which are:

1. Autonomous Flight
2. Obstacle Avoidance
3. Object Detection
4. Object Classification
5. Object Localization
6. Air Delivery

This will be the first partecipation at a competition of this kind for the team Sapienza, in fact the previous challenges in which our university has already been involved required a human controlled guidance system. Therefore the autonomous flight constraint has to be faced without previous insights on the matter.

[1]The challenge is the AUVSI-SUAS hosted in united states in summer 2018.

i. Starting Points

The areonautical research department, in the past decade, has spent a big effort working to an autonomous guidance system, that has been thinkered, designed and implemented by master students in theyr thesis.
This system allows to control the complex aerodynamics of the vehicle from an higher level of abstraction, its main high level control mode uses a series of way points that describes a trajectory.

In this way the aircraft will likely follow a path made of lines that intersects subsequent waypoints.
The system is designed to work on an on-board computer and to communicate with a ground station that will continuously send to and receive from the judges's server, telemetrical data and mission objectives.

We will use a fixed-wigs radio controlled aircraft model[2] commonly used in hobby modeling as shown in Figure 1.

Figure 1: *YAK scaled aero model*

ii. Our task

As atomic part of the team which counts several members coming from an aeronutical background, we have an uncommon area of expertise that concerns **automation** and **robotics**.
So we engaged the autonomous guidance problem that comprehend also the obstacle avoidance clause.

The competition will be organized in such a way that during the various missions of the challenge each team will receive pose informations about fixed and mobile obstacles that will be **virtual**.
Then the judges will check the success or failure in avoiding obstacles according to the **telemetry** data that they will receive from each team.
In other words, we where supposed to design a **path planning** algorith that will bring the UAV from a start position to a goal position without collisions.

III. Hardware components

i. Propulsion

The engine chosen is a **DLE55** (in Figure 2) :

1. 50 cc monocylinder petrol engine
2. reservoir capable of containing 950cc of petrol
3. Equipped with a 7, 4V LiPo battery

Figure 2: *DLE55 motor*

[2]It is a scaled reproduction (1:3 ratio) of the YAK 112

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ii. On board computing

The autonomous guidance architecture, implemented in Matlab and Simulink, is converted in compiled high speed C, Cpp language.
It will be run by Arduino Due and there will be also a Raspberry pi Model 3 that will run a kalman filter in order to process all signals from sensors.

I am arrived here

iii. Sensing instruments

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iv. Communication devices

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v. Auto pilot framework

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IV. Hybrid planner

We implemented two different strategies, since both present some shortcomings and advantages, we tried to take the best of the two worlds

i. RRT

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ii. Artificial potentials

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iii. Implementation

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V. Conclusion

$$e = mc^2 \tag{1}$$

References

[Figueredo and Wolf, 2009] Figueredo, A. J. and Wolf, P. S. A. (2009). Assortative pairing and life history strategy - a cross-cultural study. *Human Nature*, 20:317–330.