METU COMET FIGHTER UAV DESIGN

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Abstract

In this study, the design and development process of an autonomous UAV system to perform dogfight is introduced. The dogfight mission for this vehicle is described as determining an ideal target for itself from many targets, reaching and locking the target via position based tracking and visual guidance. The design includes aerodynamic, mechanical, and electronical subsystems, and software pipeline. First of all, a mini class UAV system that can perform airborne maneuvers for the dogfight mission is designed and the components for the communication and control systems are determined. Then, a new hybrid airborne UAV tracking method is proposed for visual navigation, with an agile control system that enables autonomous dogfight abilities.

Keywords: Fixed Wing UAV Design, Target Optimization,autonomus dogfight, airborne UAV tracking, visual guidance.

Motivation

The study aims to find a design solution for tracking of mini-class UAVs by a mini-class fixed wing UAV with a camera. The use of mini-class UAVs for civilian or military purposes is gradually increasing [1] and as a result, detection, tracking and destruction of UAVs with potential risk plays an important role. Although this is the main motivation in the design of the designed vehicle system, it is not limited to it. With the increase in the use of unmanned aerial vehicles in the military field, it is expected that UAVs will be included in dogfights [2]. It is aimed to develop a mini-class scale unmanned aerial vehicle that can perform such an operation at a basic level. It is also aimed to develop algorithms to complete such a design.

Experimental & Procedure

Image Processing

In this part, image processing algorithms will be discussed. For real time guidance, image processing algorithms are required so that the rival UAV would be located on the onboard camera with respect to our UAV. Image processing algorithm consists of two parts, object detection and object tracking respectively. Once the rival UAV is detected and localized with an object detection algorithm, its output is fed into the object tracking algorithm. Then, the object tracking algorithm tracks the rival UAV until N frame passes if the tracking algorithm work in an confidence interval. Object detection and object tracking algorithms work succesively in a way that they enhance the deficiency of each other as in the figure below and for each frame, error vector corresponding to the distance between centre of the bounding box and the centre of the image, is fed to the controller. Benchmark tests [6-12] of state of art algorithms are investigated during the literature research to find most appropriate algorithms for our case.

Algorithm 1: Algorithm to detect and track airborne UAVs

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Data: Realtime Image Frames
Result: Bounding Box Coordinates of the UAV
cnt ← 0;
detection_initiated ← False;
object_detected ← False;
rect ← [0, 0, 0, 0];
frame_per_detection ← N;
while True do
    frame ← current frame of the stream;
    cnt ← cnt + 1;
    if cnt%frame_per_detection = 0 or not detection _initiated or not object_detected then
        detection_initiated ← True;
        rect ← object_detection_model(frame);
        tracker ← Tracker_initializer(frame, rect);
        Tracker_is_initilized ← True
    else
        if Tracker_is_initilized is True then
            rect ← obejct_tracking_model(tracker, frame);
            if score of the tracking of the tracking ≤ threshold then
                Tracker_is_initilized ← False;
                object_detected ← False;
                continue
            end
        else
    end
end
```

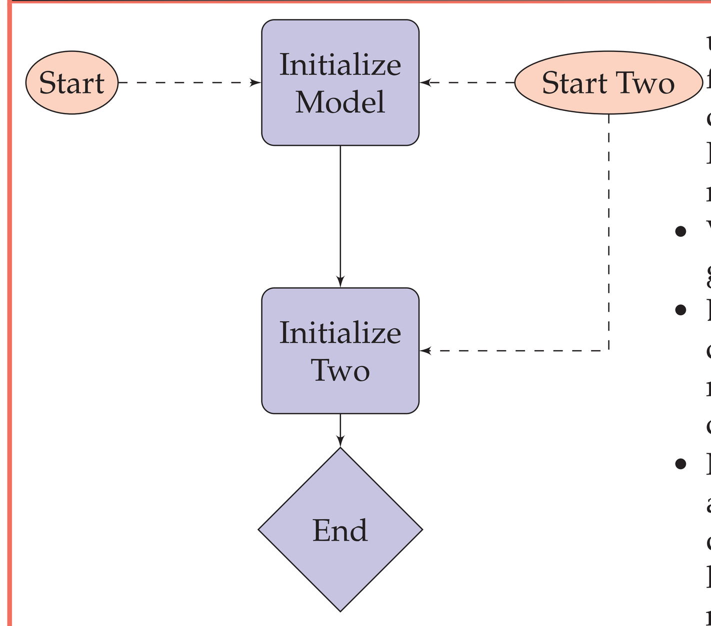
Mission algorithms and control system.

The main strategy in the autonomous lockdown algorithm is to select the ideal target, approach the target from behind and lock it, and keep the target within the camera view with vision-based guidance. The steps and related explanations required for this strategy are given under this heading.
For autonomous locking, firstly the target must be approached from the appropriate angle and distance so that the next stage of the mission, vision-based guidance, can be performed. There are two requirements for this approach, which are target selection and path planning. To make the target selection less complicated, the rival UAVs are assumed to be identical and they have the same flight characteristics as the designed vehicle.
In order for the UAV to approach the target correctly, a path suitable for the flight characteristics must be generated between the current location and the target location

To generate such paths in 3D environments from vector to vector with constraints such as turning and climbing, an improved version of Dubin's path from 2D to 3D, also named Dubins Airplane, is proposed in the following paper[4]. While this work is the reference point for the implementation by our team, it does not exactly match the work of Owen and others. Along with this implementation, which was developed over the vector field methodology, Demirdal's study is also used as a reference in the developed software [5].

Results 1

Conclusion



- Pellentesque eget orci eros. Fusce ultricies, tellus et pellentesque fringilla, ante massa luctus libero, quis tristique purus urna nec nibh. Phasellus fermentum rutrum elementum. Nam quis justo lectus.
- Vestibulum sem ante, hendrerit a gravida ac, blandit quis magna.
- Donec sem metus, facilisis at condimentum eget, vehicula ut massa. Morbi consequat, diam sed convallis tincidunt, arcu nunc.
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BLA2K

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Results 2

Additional recommendations:

- Structure your poster by Abstract, Methods, Results and Conclusions.
- Every graphic/table should have a caption.
- Do not justify blocks of text on both sides.
- Highlight your main finding.
- If possible, avoid abbreviations and acronyms.
- Where possible, express points as bullets rather than paragraphed text.
- Use a constant font throughout the poster.

Rule of thumb: The poster is supposed to be readable in screen laptops. Check your final design in full screen.

Figure 1: Figure caption

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