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Automatic Control and Computers Faculty,
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BACHELOR THESIS

Unmanned Aerial Vehicles, Formation Flight

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Va multumesc tuturor pentru ajutorul acordat in elaborare

TODO:
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Abstract

Here goes the abstract about UAV Formation Flight.

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Write abstract

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Notations and Abbreviations

RC – Remote Control

UAS – Unmanned Aerial System

UAV – Unmanned Aerial Vehicle

Chapter 1

Introduction

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WRITE INTRODUCTION CHAPTER (1-2 pages)

1.1 Domain Description

In the last 3 decades the aeronautic industry has focused on creating methods of flying that does not involve a human factor inside the airplanes, developing solutions for unmanned flight.

The necessity for advancements in domain is powered by the desire to keep human pilots out of harms way. UAV systems are useful in military missions, and high risk search and rescue missions. Along the military missions, UAVs can be used in civil context for missions like: traffic surveillance, cartography or animal tracking.

An or drone is a vehicle that doesn't have a human pilot on board and can be either controlled by a , a ground control system (Control Tower) or be fully autonomous. The concepts of unmanned vehicles emerged a couple of years after the first mechanized flight in 1903 by Orville and Wilbur Wright [2]. In 1915 Nikola Tesla had a vision about a fleet of unmanned military aircrafts and in 1919 was developed the first UAV by Elmer Sperry, that was used for sinking a captured German battle ship.

The first two countries that saw the high potential of unmanned vehicles were U.S.A and Israel. In 1960 the U.S. Air Force started a research program for developing UAVs, and in 1964 is the first documented use of an UAV in a real war scenario, during the Vietnam War. Israel started using UAVs for reconnaissance and surveillance mission. As a result, Israel reported no downed pilot during the Lebanon War in 1982. In the present, drones are intensively used in the war theaters from Afghanistan and Iraq [1].

The development of the autopilot is strongly correlated to the with the developed of the UAV. The company of Elmer Sperry was the first to produce an autopilot that was able able to fly autonomous for three hours in a straight line without being supervised by a human. By 1933 Sperry's autopilot was able to flight on true heading and maintaining the altitude, compared to the gyroscopic heading of the first version.

The current evolution of autopilots is in close relation with the development of reliable communication systems. Although the first UAVs were controlled remotely by a human operator, they are now able to receive a flight plan and based on that to calculate the flight path and follow it to complete the mission. In moder autopilots the human factor the secondary role of supervising the system and controlling the on board equipment, like cameras and sensors.

1.1.1 Motivation

When I was 4 years old I received my first toy airplane and became fascinated by the idea of moving freely like a bird. At 10 years old I first stood near a MIG-21 Lancer at my fathers garrison. The passion with witch the pilots talked about being in the air close to the clouds inspired me the love for moving freely in 3 dimensions.

The high number of human casualties reported in war theaters and training missions determined me to explore the field of autonomous fling. The necessity for reducing the loss of human lives gives autonomous great potential for evolution.

My motivation is to help create a next generation of autopilots capable of accomplishing difficult missions where it is the risk for a human pilot would not be affordable.

1.1.2 Objectives

Although a single UAV is already able do accomplishing various mission by it's own, an interesting, and in my opinion mandatory, field is the one of fling in formation. A mission where the objective is to track multiple targets becomes very hard for a single drone, thus emerging the necessity for a swarm of UAVs. There are situation where the risk for loosing an UAV due to hostile conditions is to high, being more affordable to deploy multiple, cheaper UAVs in contrast to an expensive drone. Another use case for a formation would be a search mission where we can't equip a single aircraft with all the sensors necessary for success and choosing to use multiple specialized drones.

Usually a human pilot is able to fly in formation using a combination of cognitive and reactive behavior, always making small adjustments to maintain a coherent formation.

There are two ways that formation flight could be achieved. One would be a centralized method, where all the drones report the telemetry data to a central authority like a ground control system and the later would make the necessary decisions for all the involved actors and then relay the data back to the aircrafts. Although in theory this approach could give an optimal flight path, problems like delay in communication and sensors reporting faulty data could jeopardize the success of the mission. Another approach would be a decentralized method, inspired by swarms of animals, like ants or bees. In the second approach each UAV would decide what actions to execute based on the actions of the others.

The main goal of this thesis is to design an decentralized algorithm responsible for maintaining a flight formation based on the leaders actions. The leader will not share the flight path or mission plan with the other drones, it will share only the current position, speed and direction. Based only on this date, the drones must be able to maintain a predefined flight formation. Thus each drone, except the leader, is modeled as an reactive agent that has the mission to approach the leader and mimic his actions.

The secondary goal of this paper is to design a management platform for a fleet of airplanes that are able to execute different missions. The platform has the role of programming the mission for each drone, manage the in flight performance for each UAV and if necessary to send commands, inserted by a human supervisor, to the drones and by this modifying the current state of the mission execution.

This thesis present my approach for UAV Formation Flight.

Chapter 2

Related Work

TODO:
Describe related work

We can also have citations like [?].

Chapter 3

UAV Management Platform

3.1 Architecture

TODO:
Describe architecture

3.2 Functionalities

TODO:
describe functionalities

TODO:
Describe management framework

Chapter 4

Formation Flight

4.1 Coordinates Systems

4.1.1 Latitude, Longitude, Altitude

TODO:
describe lla

4.1.2 Earth-Centered, Earth-Fixed

TODO:
describe Ecef

4.1.3 Conversion

TODO:
describe lla-to-ecef

4.2 Formation types

TODO:
describe formation types

4.3 Entering the formation

TODO:
Describe Formation Entering

4.4 Maintaining the formation

TODO:

Describe entering the formation

Chapter 5

Implementation details

TODO:
describe implementation details

5.1 FlightGear

TODO:
talk about FlightGear

5.2 QGroundControl

TODO:
talk about QGroundControl

5.3 MY CODE

TODO:
talk about code, class-diagrams, describe methods, data-structures

Chapter 6

Use cases

TODO:
describe use cases

TODO:
captures of 3 formations

TODO:
captures of flight-path

TODO:
possible missions

Chapter 7

Conclusions and future work

TODO:
describe conclusions and future work with low priority

TODO:

Add appendixes

Bibliography

- [1] M. E. Dempsey. Eyes of the army - u.s. army roadmap for unmanned aircraft systems 2010-2035. U.S Army, Fort Rucker, 2010.
- [2] Thomas Benson Roger Storm. Learning to fly: The wright brothers' adventure. National Aeronautics and Space Administration, 2002.