* Mission Definition and Analysis of Requirements:
  + Define the typical mission for the assigned aircraft, including an exhaustive illustration and description of all its segments.
  + Perform a critical analysis of the requirements for the aircraft design, including assumptions and estimations for missing requirements.
  + Identify and discuss the driving or most critical requirements for the design.
* Reference Aircraft Data Collection:
  + Collect and organize reference data of existing aircraft similar to the assigned one, aiming for around 20 reference aircraft.
* Concept Generation and Selection:
* Propose at least three different aircraft configurations with sketches and descriptions5.
* Select the best concept and explain the selection process6.
* Study and Generation of the Complete Fuselage Layout:
* Perform a study of possible fuselage layouts using the inside-out approach, including calculations and dimensions7.
* Make sketches of different possible payload configurations to demonstrate the flexibility of the design8.
* Generation of Technical Drawings:
* Provide technical drawings of the fuselage design, including top, side, front views, and relevant cross and longitudinal sections9.

Introduction

The following report consists of 5 chapters, each guiding the reader through the aircraft design process. This first chapter will provide a definite mission for the aircraft and will analyze its design requirements. The second chapter will analyze reference aircraft similar in specifications to those required by the design mission, as well as including an appendix with the relevant reference material within. Chapter 3 discusses the concept generation for the aircraft design and details the process of selection between the three concepts we had created, and how the selected concept best meets the mission requirements. Chapter 4 will show the complete fuselage layout for the aircraft. And Chapter 5 will contain technical drawings of the concept aircraft design.

1. Mission Definition and analysis of requirements

In the introduction the basic requirements for a Low Altitude High Endurance UAV were given. This list of requirements, however, is insufficient in relaying the totality of the requirements needed for the execution of this design mission. FAA requirements considering low altitude UAV systems, specifications surrounding payload packages, and necessary considerations for the compacted design all will be explored and accounted for within the following chapter.

* 1. The Mission

For the LAHE UAV the mission typical mission profile is one built around observation. Initially the aircraft must be launched by a single operator in a remote environment. Following launches the aircraft must climb to its cruising altitude of 400m where it will maintain a cruise speed of 10 m/s. The mission profile sees very little change once cruising altitude and cruising speed are reached and observation can begin. Since the primary objective of the mission is to employ a microphone sensor package to survey wildfires, the observation stage of the mission profile sees very little deviation from its cruising altitude during this stage of the mission. Observation will continue until aircraft endurance is exhausted to a point of required landing. The craft will then be flown back to its operator where it will descend in a spiral before landing for operator recovery.

* 1. Requirement Analysis

Once the required function of the aircraft is ascertained, a set of requirements must be made to meet the needs for such function. In this section, the given requirements will be critically analyzed to understand how each will affect the aircraft. Additional requirements must also be accounted for to properly configure the design.

1.2.1 Payload Analysis

It is noted that the express purpose of this aircraft is to deploy a microphone listening package for data collection. This listening package makes up the whole of the aircraft payload and though this payload is static within the aircraft the design of the fuselage must accommodate the needs of the payload for data collection. The primary requirement is that the payload microphone must be exposed outside of the aircraft so that it can be utilized. Thus, the aircraft fuselage must be open. The exposed microphone will be of the dimensions \_\_\_\_\_\_\_\_\_\_\_, and weigh \_\_\_\_\_\_. As a result of the necessity for payload exposure the overall drag on the aircraft will be increased. To make up for the excess drag an increase in wingspan will be required. Along with the data collection aspect of the payload, accessibility for data recovery is also required. The fuselage must be designed with an access panel so that the payload can be removed. Further adjustments for the payload must also be made as a data storage device and an independent power supply must be accounted for. These aspects of the payload would be of the dimensions \_\_\_\_\_ and \_\_\_\_, and will weigh \_\_\_\_\_ and \_\_\_\_\_\_.

The aircraft’s main power supply must also be accounted for in the payload as during use the LiPo batteries that power the craft will see a change in weight as their energy is expended. At full charge the two LiPo batteries that make up the power supply weigh 1.44 kg, and when fully expended weigh\_\_\_\_.

As a UAV remote control is critical to the operation of the craft, thus an external antenna must be mounted to the fuselage of the aircraft. This will create additional drag on the aircraft in a similar manner to the microphone payload and thus will require an increase in the wingspan to account for the excess drag.

1.2.2 Propulsion Analysis

With a proposed cruise speed of 10 m/s and a payload weight of 2 kg, propulsion can easily be achieved using electric engines. Thus, the proposed method of propulsion will be that of a brushless electric motor. The primary issue however in deciding the type of brushless electric motor for the aircraft lies in balancing its weight to torque output. A motor that weighs very little and outputs a high torque would be ideal these motors however are not common. Thus, for this assignment the aircraft will be powered by a brushless electric motor with a high torque to motor weight ratio.

1.2.3 Certification Analysis

According to FAA regulations small UAS must weigh under 55 pounds, the operator must pass an FAA provided knowledge test and requires registration of the craft with the FAA. UAS less than 55 pounds may be registered under the FAA's newer 14 CFR Part 48 online system.[1] The craft must also fly within visible line of sight which is defined as within 3 miles of the operator. The operator is also required to fly under 400 ft as well as remain in compliance with all airspace restrictions and prohibitions. For any flights beyond the distance and altitude limits licensed operators are required to apply for a exemption waiver with the FAA in order to fly legally. The FAA will provide a certificate of registration to the operators which must be available for inspection at any time that the craft is in operation. Along with the certificate UAS must also have a registration number visible on the aircraft.

1.2.4 Range, takeoff, and landing distance.

This aircraft is a fixed wing UAV designed to weigh under 55 pounds to remain within FAA regulations. As a result, takeoff and landing distances are mostly arbitrary due to the lightweight nature of the aircraft and the necessity for rapid deployment. The required range for the aircraft is 100 km. With this range in mind the craft will be designed to maximize its airtime endurance and minimize power expenditure to remain in the air as long as possible. In order to achieve this range, the aircraft endurance will be extended via the use of a large airfoil allowing for the aircraft to glide while using minimal battery power for propulsion.

1.2.5 Additional Requirements

1.3 Driving Requirements

The critical requirements for this aircraft will be range, endurance, and payload. All three of these requirements have an impact on the cruise speed and max speed requirements for the craft as their balance will dictate the type of electric motor that can be utilized.

2 Reference Aircraft Data Collection

During the concept creation process it is critical to have a range of reference craft from which you can draw inspiration as well as use for comparison to your own craft requirements. All reference aircraft used in this design are included in Appendix \_\_ below. The scope of the specification of these craft varies in all aspects to provide a range of understanding how increases in certain requirements may impact overall craft design. Ultimately, however, the majority of the reference aircraft retain similar characteristics to those required for our design as they provide useful insight into how issues with our design solutions may have been included in the designs of others. It is important to note that blank areas of the table represent design aspects for which no information was found. This appendix will be continuously updated throughout the whole of the design process as additional references are added or additional requirements are necessitated for further progress in the design process.



Sources:

[1]https://www.faa.gov/air\_traffic/publications/atpubs/aim\_html/chap11\_section\_2.html