The Aerodynamics Analysis of Type UAV Aircraft with Pusher Engine Configuration by Use of DATCOM Software.

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ABSTRACT

In line with the advancement of micro processor technology, availability small scale aircraft engine model, light weight material and also better understanding in the aircraft design process had brought a current attention to develop autonomous flying vehicles. This kind of vehicle has offered various applications, such as military and civilian purposes. However to develop such kind autonomous flying vehicles one have to develop a control law which govern how the flying vehicle to fly. To do so one have to prepare firstly the required aerodynamics data. The present work focused on the type of flying vehicle powered by electric type of engine. This type of engine is normally available in the market is at the size of engine less than 5 hp. Due to the engine limitation, the size of flying vehicle. has been decided to the aircraft configuration with all required devices for autonomous they vehicle is no more than 6 Kg. through series of aerodynamics assessment aircraft components (fuselage, wing, airfoil on the control surface and it's high lift devices). the present special write produce an initial aircraft configuration with aerodynamic data which can be future studied for development that aircraft as an autonomous flying vehicle.

ABSTRAK

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDIX

CHAPTER 1

INTRODUCTION

1.1 Major department: Mechanical engineering

This thesis presents the preliminary design airframe dedicated for the future use of the development UAV system. The airframe will be powered by propeller electric engine placed in the back side. The airframe designed to be able to accommodate a flight control system, two high resolution cameras, onboard video recording device, GPS points and altitudes and battery system. Innovative robust construction coupled with light weight and inexpensive hardware was used in the design of the airframe and avionics. These features allow the airplane to be operated by unskilled users.

1.2 Various unmanned aerial vehicles (UAV)

Unmanned Aerial Vehicles (UAVs) have proven their usefulness in military reconnaissance in recent military conflicts [1]. Their practical applications have been expanding to more than military uses [2]. Various sizes of UAVs are designed to different levels of performance depending on their application. UAVs can be categorized into four different groups: large, medium, small, and micro as shown in Figure 1.1.

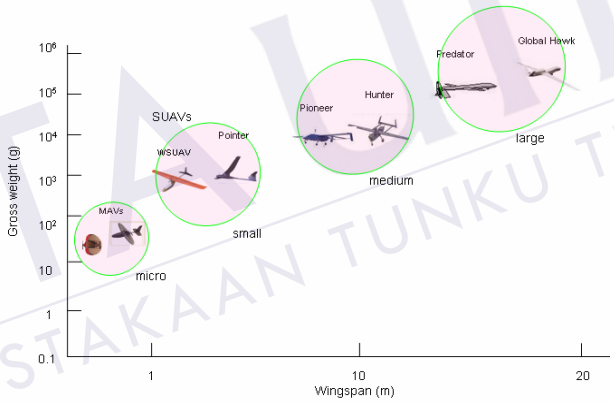

Figure 1.1: UAVs can be divided into four groups by respect to its sizes and weights

Most of the large UAVs have higher flight ceiling, speed, and endurance with more functional capabilities than small UAVs. The representative large UAVs are Northrop Grumman Global Hawk (20m wingspan) [3]. And General Dynamics Predator (14.8m wingspan) [4]. They have proven their performance in recent missions. Large UAVs are more suitable for large land or over-water surveillance. The effectiveness of large UAVs has been proven in the Gulf War and Desert Storm. Table 1.1 shows typical airframe data of large UAV.

The representative mid-size UAVs are AAI Shadow (3.9 m wingspan) [5] And IAI Malat Hunter (8.8 m wingspan) [6]. Most mid-size UAVs do not require runways because takeoff requires a catapult mechanism and landing uses a parachute. UAVs of this size are commonly used for tactical military missions such as target acquisition, over-the-horizon surveillance, and battle damage assessment.

Table 1.1: Typical airframe data of large UAV

	BQM-74	BQM-145A	CL-289
Weight (Kg)	123	98	78
Wing Span (m)	1.76	3.20	0.94
Length (m)	3.94	5.59	3.71
Speed (km/hr)	972	1016.75	740
Endurance (min)	68	49	15
Height (m)	0.71	0.86	0.33

Micro air vehicles (MAVs), as defined by Defense Advanced Research Programs Agency (DARPA), are miniature aircraft with a maximum wing span of 15 cm [7]. Currently, the MAV's mission is restricted by payload capabilities such as autopilot, high resolution camera, and battery capacity. But its size benefit has the potential to overcome the UAV's accessibility in the confined area. Recently developed MAVs by the University of Florida have an 11cm wingspan and 15 minute endurance, and weigh less than 40g [8]. The University of Florida has also developed a 15cm wingspan MAV with a reconnaissance capability within 1km range with video transmitting. The example of typical airframe data for medium UAV as shown in the Table 1.2.

Table 1.2: Typical airframe data of medium UAV

	RQ-7A/B	BQM-145A
Weight (kg)	149	98
Wing Span (m)	3.89	3.20
Length (m)	3.40	5.59
Speed (km/hr)	204	1016.75
Endurance (min)	420	49
Height (m)	0.91	0.86

1.2.1 Small unmanned aerial vehicle (SUAV)

The military has shown the most recent interest in small UAVs (SUAVs) for many reasons. A SUAV is much more portable than its large counterparts and requires only one operator. A smaller reconnaissance plane can assess ground targets at a closer range without being detected. Therefore, most SUAVs use electric motors as a propulsion system, which allows for a stealthier and more reliable flight with little engine failure. Also an SUAV is less expensive and can be considered a disposable asset. This factor allows SUAV pilots to navigate hostile areas and focus on their primary mission, rather than plane recovery. In addition to military applications, size and cost advantages are attracting civilian and private uses. Therefore, SUAVs are most suitable for use in non-military applications because they are less expensive

and less dangerous. This encounter proves the need for smaller, more invisible, and more portable SUAVs.

The Aero vironment Pointer (2.7 m) SUAV was the first generation of SUAVs in 1986 [9] and was designed as a tactical reconnaissance vehicle for military and law enforcement applications in confined areas. When it was released, a package of 2 airplanes and a ground station cost $100,000. This is relatively inexpensive in comparison with mid or large size UAVs that can reach millions of dollars. The Pointer's size and reliability has already proven itself useful in Desert Storm [8]. Table 1.3 shows commercial SUAVs that are constructed by composites and are mostly designed for the military application.

Table 1.3: Typical micro UAV airframe data

	Bird Eye 500.	RQ-11A
Weight (kg)	5	1.9
Wing Span (m)	2	1.3
Length (m)	1.6	1.1
Speed (km/h)	22-60	95
Endurance (min)	90	80

Table 1.4, shown the wingspan and flying time of the SUAV are compared according to the manufacturer and its product.

Table 1.4: The wingspan and flying time of the SUAV.

Name	Manufacturer	Wingspan (m)	Endurance (hr)
Pointer	AeroVironment	2.7	2
Raven	AeroVironment	1.28	1.5
Dragon eye	AeroVironment	1.14	1
Casper-200	Top vision	2	1
Skylark	El bit	2	1

1.3 Back ground

In parallel of the advancement of computer technology, material, propulsion system and better understanding on the aircraft stability had made the development of autonomous flying vehicle becomes an attracted matter. The applications of UAV are widely had been recognized whether for civilian or military purposed. The military purposes may the UAV can serve for:

1. Reconnaissance surveillance and Target acquisition (RSTA).
2. Surveillance for peacetime and combat synthetic aperture radar (SAR).
3. Deception operations.
4. Maritime operations (Naval fire support, over the horizon targeting, anti-ship missile deference, ship classification).
5. Electronic warfare (EW) and SIGNT (SIGnals INTTelligence).
6. Special and psyops.

7. Meteorology missions.

While for civilian applications, the UAV can be used for:

1. Communications Relay. High altitude long endurance UAVs can be used as satellites.
2. Law Enforcement. VTOL UAVs can take the role of police helicopters in a more cost effective way.
3. Disaster And Emergency Management. Arial platforms with camera can provide real time surveillance in hazardous situations such as earthquakes.
4. Research. Scientific research of any nature (environmental, atmospheric, archaeological, pollution etc) can be carried out UAVs equipped with the appropriate payloads.
5. Industrial Applications. Such application can be crops spraying, nuclear factory surveillance, surveillance of pipelines etc

Considering that there are a lot of application can be served through the use of UAV, it is therefore, the ability to develop the UAV based on own design is necessary in order to limit the foreign dependence in this type of technology.

1.4 Problem statements

UAV which stand for Unmanned Aerial Vehicle represents the airplane which designed without pilot onboard. With no pilot on board make the size of the airplane can be reduced to become the size of airplane just for accommodating payload and the required fuel only. As a result the size and weight of aircraft becomes smaller and lighter than ordinary aircraft. In the stage of early

development, the design purposed of UAV is for monitoring, hence the payload is the video camera and the communication system which required for sending a video data recoding to the ground. Unfortunately to obtain a long range communication system is very difficult. Such devices are very restricted and can be used without permission from the authority body. To avoid such restriction on the communication device, the purposed aircraft configuration will be designed in typical size of (RC) aircraft. Actual size of the aircraft will be determined on the size of engine, the size of the communication hardware, flight control computer board, video camera and the battery system.

1.5 Thesis objective

The purpose of this thesis is to carry out preliminary design of airframe dedicated for the future UAV developments. The airframe had been selected to be single engine with pusher type configuration. The airframe will be powered by an electric engine. The aircraft sizing developed based on the engine available, flight control system, communication system, two high resolution cameras, GPS points and altitude. There various aircraft configuration of pusher type can be developed. However the present work will focus on one possible configurations similar to the airframe configuration as shown in the Figure 1.2 bellows:

Figure 1.2: The Purposed Aircraft Configuration Model – 1.

1.6 Scope of study

The present work is attended to develop the UAV system for monitoring purposes. As the stage of early development, the UAV designed for the range of typical RC aircraft with payload is video camera. It is therefore, the scope of study will involve:

- ✓ Review on the availability autopilot devices.
- ✓ Video camera model for monitoring purposes.
- ✓ Radio Control.
- ✓ Electric engine and propeller.
- ✓ Airframe design.

CHAPTER 2

LITERATUR REVIEW

2.1 Mission profile and overview

Any aircraft designed without pilot on board called as unmanned aerial vehicle (UAV). Without pilot on board made the size of vehicle can be reduced significantly but at the same time the ability to maintain their safety flight are highly demanded. In line with the progress of aircraft technology development in respect to the design procedures, material, manufacturing and the rapid progress in electronics, communication system and computing power had made a further effort for UAV's development becomes apparent. The UAV has gained interest for military or civilian users. Military users may look the UAV with a particular design

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