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Designing and Manufacturing of Remote Controlled Aircraft with Vertical Takeoff for Surveillance Purpose

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Abstract - *A Radio-Controlled aircraft is a small flying machine that is controlled remotely by an operator on the ground using a hand-held radio transmitter. The transmitter communicates with a receiver within the aircraft that sends signals to servo-mechanisms which move the control surfaces based on the position of joysticks on the transmitter. The control surfaces, in turn, affect the orientation of the plane.The design objective of the team is to build an efficient Vertical Take-off and Landing (VTOL) Remote Controlled aircraft for a purpose of surveillance, while simultaneously pursuing the highest payload fraction as possible. After analyzing the objectives, the projects motive is to reduce the weight and dimension of the aircraft model and simultaneously increasing the lift. An objective of the conceptual design process is to obtain possible solutions that will satisfy the given design request. Possible solutions are compared and analyzed using figures of merit extracted from the analysis of the mission goals, requirements, and the design constraints.*

Key Words: **Radio-Controlled aircraft, control surfaces, vertical Take-off and Landing, surveillance, payload fraction, lift**

1.INTRODUCTION

Remote controlled aircraft is a flying machine that is controlled by an operator using radio-transmitter . The transmitter communicates with a receiver within the aircraft that sends signals to servo-mechanisms which moves the control surfaces. It is often called as Unmanned Aerial Vehicle which is equipped with a wireless camera for surveillance purpose. Surveillance is critical for military, law enforcement, and search and rescue operations. In the past, stealth aircraft and helicopters were used for these types of missions. The reasons why remote controlled aircraft is used over drone is because its capability to fly at high altitude over wide range of speed. Also, remote controlled aircraft has an edge over drone in terms of its fewer complexities in construction. Therefore, remote controlled aircraft have grown in popularity. Since this is a common capability of remote controlled planes, this project sought to create surveillance device that is autonomous, inexpensive, lightweight, and easy to manufacture.

1.1 Literature Review.

Andy Lennon [1] has written an outstanding book that covers all required aspects of the preliminary design process for model aircraft. Further, much of the content is equally applicable to homebuilt aircraft design and other applications. This book covers concepts of aerofoil selection, aerodynamic formulas, tail design, wing design etc. Naresh k.[2] This book demonstrates the construction of an RC aircraft, the theories behind these miniature structures and the specifications of the components assembled in the designed RC plane. Moreover, explaining the intricate details of mechanical and aerodynamic properties of the RC airplane. Neha Mathur[3] In this Research paper, the analysis of drag and lift forces of a delta wing aircraft has been found. From the development of the first powered flights (1903) to the present time, the study of the aerodynamic design has played an important role in the airplanes optimization. Traditionally it has been in the hands of the designer's experience, tests of flight and wind tunnel experiments, being this last tool the one that has provided a method of systematic study and the capability of making inexpensive adjustments of control parameters in a design. Zaw Min Naing, Win Khine Moe[4] In this Research paper, demonstration of the vertical take-off system design, build, and aircraft mode considered. These criteria will development the appropriate operating envelope required to be incorporated into the design. Next the wing design is selected. And then, the dynamic stability check is calculated.The design and implementation of the Vertical Take-Off and Landing aircraft and carried out to bring out the Mathematical Model of the Vertical Take-Off and Landing aircraft. Fred.E.W Weick and Robert T. Jones [5] An analysis of the principle of results of recent NACA lateral control research. It covers the information regarding analysis of different types of ailerons, control surfaces. This book demonstrates optimization of the minimum induced drag of aerofoils, aerodynamic forces, elements of the wing section theory

1.2 Problem Statement

To provide Vertical Take-off for remote controlled aircraft for surveillance purpose and to carry weight of apparatus for surveillance.

Constraints : 1. Fixed wing aircraft
2. Max. wing span- 1000 mm

3. Max weight- 1500 gm
4. Aspect ratio- 2-6
5. Sweep angle- 10°-20°

2. Actual solid model

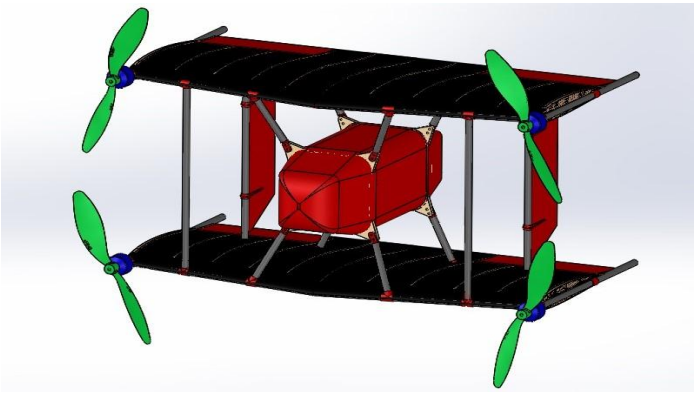

Fig -1: 3D Model

i. The above presented aircraft model combines the advantages of a drone and a remote controlled aircraft which is suitable for surveillance purpose.
ii. The model is consist of two wing with four rotor attached to the tip of the wing.
iii. The control surfaces consist of ailerons and rudder are attached to the another side of the wing.
iv. Electronics part consist of battery, motor, ESE, receiver, arduino, relay, antenna and wiring weighing 550 gm in total
v. Most of the electronics is positioned in fuselage which is middle part of the aircraft
vi. For the surveillance "RunCam Eagal 2 Pro" camera is used which is 15 gm in weight
vii. For communication of signals "MATEK SYSTEM VRX-1G3-9 FPV video transmitter" is used.

➢ VTOL configuration

➢ A vertical take-off and landing (VTOL) aircraft is one that can hover, take off, and land vertically. This classification can include a variety of types in specific to our design of aircraft including fixed-wing aircraft.
➢ The functioning of VTOL in our design is similar to a UAV(quad-copter) except the matter of fact that the airplane has the ability to switch between flying modes as conventional plane and a hovering quad-copter with the ability to land and takeoff vertically.
➢ This is achieve by switching from 4 motors to 2 motors after getting the specific height
➢ After taking off vertically by using four motors (rotors) when it gets specific height, 2 motors at bottom will shut off, so that the aircraft will change its orientation and fly horizontally parallel to the ground
➢ This is achievable by using relay and arduino in circuit which is given in the following driagram

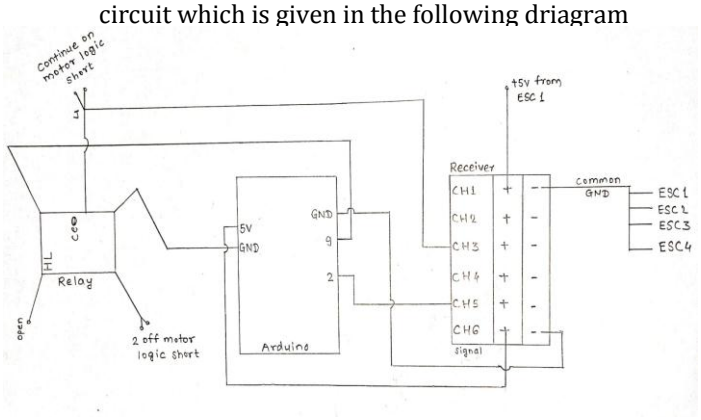

Fig.2: Relay Connections

3. DESIGN CALCULATIONS AND ANALYSIS

Part A:-Design calculations

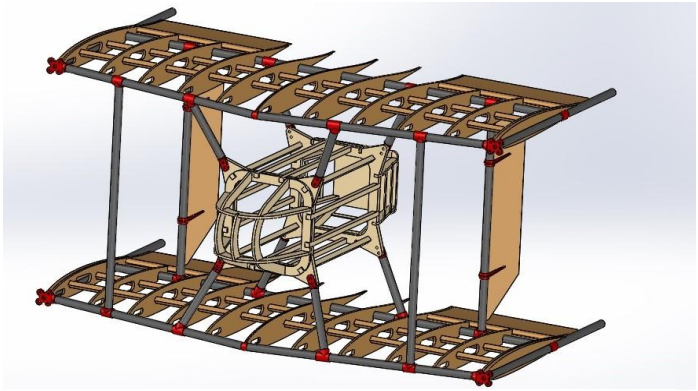

Fig.-3: skeleton of aircraft

➢ Following calculations are made for an efficient vertical takeoff aircraft

- No of wings - 2
- Wing span – 600mm * 2 =1200mm
- Aileron–width:171.191mm
  Breadth : `63.83mm
- Sweep angle - 10^{o}
- Wing area – 3222.22 mm^2
- Taper ratio – 0.83

➢ Airfoil

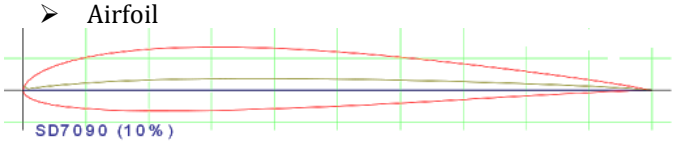

Fig.-4: MH 61 airfoil

The cross-sectional shape obtained by the intersection of the wing with the perpendicular plane is called aerofoil. As the type of our aircraft model is flying wing, we have selected an airfoil that is especially designed for the flying wing. The aerofoil selected for our flying wing

is MH 61. From the characteristics of airfoil, the max cl/cd is 31.3 at α= 7.5° at Reynold's number 50000 and N_{crit}= 9

Part B :-ANALYSIS

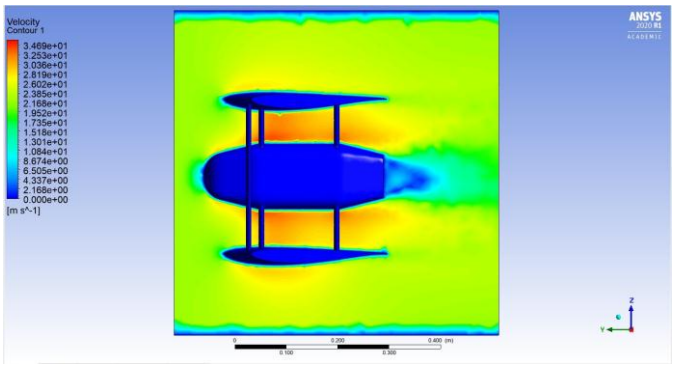

Fig.5-CFD analysis(side view)

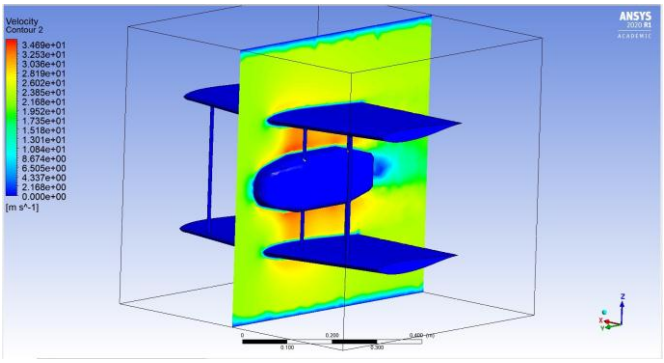

Fig.6-CFD analysis

- Fluid flow analysis is done on the CFD analysis software
- Lift generated in CFD analysis is 11.96 N which is suitable for lifting our aircraft so we can proceed for manufacturing

4. CONCLUSIONS

- The CFD analysis of solid model 'Iteration 3' was successful resulting in lift value of 11.96 N which is near to the required value.
- The lift value is slightly lower than that of the required due to computing limitations of the computer capacity.
- As the aalysis stage is completed, the model is ready to be manufactured as per the drawing.

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