Design and Fabrication of Unmanned Amphibious Aeromobile

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Abstract: ***There is a requirement of system which can monitor, Surveillance, React to the situation appropriately based on requirements in military and civil application, this technology will be able to provide solutions for infiltrations in border areas, collect information, transmit data back to the base camp, this system also plays a very important role in civil sectors, for collecting deep forest, deep see, and Arial data for weather predictions and other research works Technology has been upgraded and updated from past many decades time to time, nevertheless there is a striving requirement for more advancements in the coming near future. Even as the world powers are concentrating more on research and developments in Defense sector, a Military and a civil based technological development is in dew. The UNMANNED AMPHIBIOUS AERO-MOBILE (UAAM) is a state of art cutting edge technology that can be used for Military as well as civil based applications depending upon the requirement in different sectors. UAAM will be a completely new concept which can be termed as multipurpose drone for various on ground, air and water surveillance and other requirements.***

Keywords: unmanned, Surveillance, infiltrations, defense.

1. Introduction

Technology has been upgraded and updated from past many decades time to time, nevertheless there is a striving requirement for more advancements in the coming near future. Even as the world powers are concentrating more on research and developments in Defense sector, a Military and a civil based technological development is in dew. The **Unmanned Amphibious Aero-Mobile (UAAM)** is a state of art cutting edge technology that can be used for Military as well as civil based applications depending upon the requirement in different sectors. It is an all-weather and all terrain system capable of countering rough and rugged situations. Earlier there has been very little research done on such a technology which is a very important requirement in different sectors. UAAM will be a completely new concept which can be termed as multipurpose drone for various on ground, air and water surveillance and other requirements.

2. Literature Survey

The team spent more time in literature survey studying in various commercial industries. Defense industries, research institutions and other civilian sectors. The team came across various designs of projects already carried out and few projects in the course of competition. Data were collected and analyzed in order to find out the existing problem and bring out an innovative solution. The following were the procedures followed during the literature survey:

- Identifying the problem in the UAV market.
- Comparison between the existing technologies.
- Collection and analysis of data.
- Analysis of ergonomics and economics.
- Preparing a feasibility report.
- Selecting the best alternative.
- Applying mathematical models to generate optimal solution.
- Analysing the effectiveness of the solution with the existing data.
- Implementing the solution.

Based on the literature survey conducted, the team has decided to fill the gap in technology by incorporating an amphibious part for a UAV and making it multiple platforms and multi-purpose product. It was then decided to title the project as design and fabrication of unmanned amphibious aero mobile. The overall aircraft [prototype configuration was chosen based on the survey conducted by the team.

3. Methodology

The design methodology is based on the literature survey which involves the collection of various industrial data, ergonomics, economics and choosing of the proper feasible type with the application of mathematical formulae. The design. Methodology is as follows:

3.1. Deciding the Aircraft's maximum takeoff weight:

The **maximum takeoff weight** (**MTOW**) or **maximum gross takeoff weight** (**MGTOW**) or **maximum takeoff mass** (**MTOM**) of an aircraft is the maximum weight at which the pilot is allowed to attempt to take off, due to structural or other limits Some of these requirements can only be met by specifying a maximum weight for the aircraft, and demonstrating that the aircraft can meet the requirement at all weights up to, and including, the specified maximum. These requirements include:

- Structural requirements – to ensure the aircraft structure is capable of withstanding all the loads likely to be imposed on it during manoeuvring by the pilot, and gusts experienced in turbulent atmospheric conditions.
- Performance requirements – to ensure the aircraft is capable of climbing at an adequate gradient.

Total weight including payload

$$W = 2 \text{ kg}$$

3.2. Determining the required wing loading with historical data and calculating the wing plan form area:

The ratio between aircraft weight and the wing area is referred to as wing loading and represented by W/S. This parameter indicates that how much load (aircraft i.e. weight) is held by each unit area of the wing.

Wing plan form - the shape of the wing as viewed from directly above - deals with airflow in three dimensions, and is very important to understanding wing performance and airplane flight characteristics.

Wing Structure and Constructions:
a) Rib Thickness = 2mm
b) Rib Spacing = 12.5cm
c) Wing Dihedral Angle = 4 degrees
d) Materials used for construction:

- 2mm Acro plywood.
- 2mm Balsa wood.
- 5mm polonium wood.
- 5mm foam board.
- Heat shrinking plastic for aircraft skin.

Wing Calculations:
Assumed Wing loading based on studies done by the team

$$W_L = 5.5\ \text{kg/ m}^2$$

Calculating plan form area(S):

$$W_L = \frac{W}{S}$$

$$S = 0.36\text{m}^2$$

3.3 Deciding the wing aspect ratio based on historical data analysis

Aspect ratio is defined as the ratio of wing span to wing chord. Aspect ratio is the primary factor in determining the three dimensional characteristics of the ordinary wing and its lift/drag ratio. An increase in aspect ratio with constant velocity will decrease the drag, especially at high angles of attack, improving the performance of the wing when in a climbing altitude. A decrease in aspect ratio will give a corresponding increase in drag.

Assumed wing aspect ratio

$$AR_W = 6.5$$

Calculation of Wing Span (b):

$$AR_w = \frac{b_w^2}{S_w}$$

$$b = 1.53\text{m}$$

3.4. Calculating wing span and chord length

The **wingspan** (or just **span**) of an aircraft is the distance from one wingtip to the other wingtip.

Chord refers to the imaginary straight line joining the leading and trailing edges of an aerofoil. The **chord length** is the distance between the trailing edge and the point on the leading edge where the **chord** intersects the leading edge.

Calculation of wing chord length(C_w):

$$AR_w = \frac{b_w}{C_w}$$

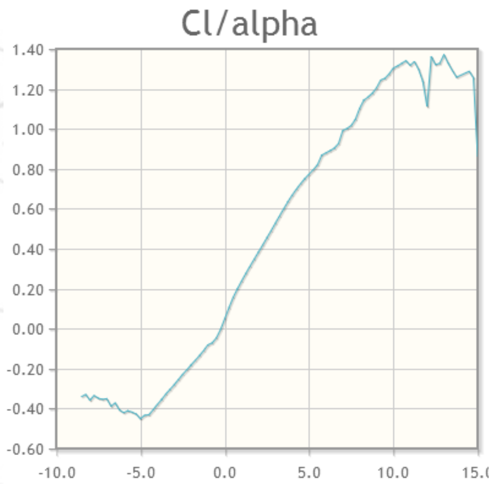
$$C_w = 0.24\text{m}$$

3.5. Determining co efficient of lift using lift equation

The lift **coefficient** (C_L) is a dimensionless **coefficient** that relates the **lift** generated by a **lifting** body to the fluid density around the body, the fluid velocity and an associated reference area.

3.6. Choosing the airfoil for wing based on required co efficient of lift value

1) An airfoil is a structure with curved surfaces designed to give the most favourable ratio of lift to drag in flight, used as the basic form of the wings, and horizontal stabilizer of most aircraft.



The airfoil chosen by the team as per particular requirement for a particular type of aircraft:
1) High Winger
2) Constant Chord Length (Rectangular Wing)

Literature Survey was conducted for the above stated type of wing & airfoil in both RC controlled and general aviation aircraft and the following data was arrived at:

- $C_{Lmax} = 1.3824$
- $V_C = 13\text{m/sec}$
- $V_S = 10\text{m/sec}$

Calculating Reynolds Number (R_e):
At STP, $\mu = 1.7875 \times 10^{-5}$

$$R_e = \frac{v \times L \times \rho}{\mu}$$

$$R_e = 2.1 \times 10^{-5}$$

Lift equation:
Assuming L = 1.5 for gaining lift

$$L = \frac{1}{2} \times \rho \times v^2 \times S \times C_L$$

$$C_L = 0.789$$

3.7. deciding the wing taper ratio requirement based on literature survey

Taper ratio (λ) is defined as the ratio between the tip chord (Ct) and the root chord (Cr). This definition is applied to the wing, as well as the horizontal tail, and the vertical tail. Root chord and tip chord

The Horizontal Stabilizer was given a taper with ratio of 0.5 based on literature survey

$$\lambda = \frac{C_t}{C_r} = 1$$

3.8. Calculating the Oswald's wing span efficiency

The **Oswald efficiency**, similar to the **span efficiency**, is a correction factor that represents the change in drag with lift of a three-dimensional wing or airplane, as compared with an ideal wing having the same aspect ratio and an elliptical lift distribution.

$$e = 1.789[1 - \{0.045 \times (AR_w)^{0.68}\}] - 0.64$$

$$e = 0.8539 = 85.39\%$$

3.9. Calculating the mean geometric chord of the wing

The **mean geometric chord** is the **chord** of a rectangular **wing** having the same span and. the same area as the original **wing**.

$$T_{MGC} = \left(\frac{b}{c}\right)\left(\frac{1+2\lambda}{1+\lambda}\right)$$

$$T_{MGC} = 0.3825m$$

3.10. Design of horizontal and vertical stabilizer

The **stabilizers**' job is to provide stability for the aircraft, to keep it flying straight. The **vertical stabilizer** keeps the nose of the plane from swinging from side to side, which is called yaw. The **horizontal stabilizer** prevents an up-and-down motion of the nose, which is called pitch.

Calculations:

Horizontal Stabilizer:

$$\frac{S_H}{S} = 0.15$$

$$S_H = 0.054m^2$$

Assuming $AR_H = 6$, based on literature survey

$$\frac{b_H^2}{S_H} = AR_H$$

$$b_H = 0.57m$$

$$AR_H = \frac{b_H}{C_{avg}}$$

$$C_{avg} = 0.095$$

Also, $C_{avg} = \frac{C_t + C_r}{2} = 0.095m$

$$C_t = 0.065m$$

$$C_r = 0.125m$$

Vertical Stabilizer:

$$\frac{S_v}{S} = 0.02$$

$$S_v = 8 \times 10^{-5} m^2$$

$$\frac{b_v^2}{S_v} = AR_v$$

Based on literature survey, AR_v was chosen As 5,

$$b_y = 0.2m$$

$$S_v = b_v \times C_t$$

$$C_t = 0.04m$$

Based on literature survey, taper ratio is assumed to be 0.2

$$\lambda_v = \frac{C_t}{C_r}$$

$$C_r = 0.2m$$

$$C_{avg} = \frac{C_t + C_r}{2} = 0.12m$$

3.11. Deciding the tail moment arm

Moment Arm is the Distance. The **tail** was redesigned because the forward fuselage was shortened (reducing weight forward of the wing and the center of gravity) and the old **tail** wasn't capable of generating enough down force to keep the aircraft balanced.

3.12. Finalizing the fuselage length

The **fuselage** is an aircraft's main body section. It holds crew, passengers, and cargo. A conventional high, mid or low wing design, like a trainer, sport or aerobatic model, the length of the fuse should be 75% of the wing span, and of that measurement the nose moment should be 20% and the tail 40%.

3.13. Design of control surfaces

Moveable **surfaces** on an airplane's wings and tail allow a pilot to maneuver an airplane and **control** its attitude or orientation. These **control surfaces** work on the same principle as lift on a wing. They create a difference in air pressure to produce a force on the airplane in a desired direction.

3.14. Determining the Cg location

The **center of gravity (CG) of an aircraft** is the point over which the aircraft would balance. The center of gravity affects the stability of the aircraft. The center of gravity affects the stability of the aircraft. To ensure the aircraft is safe to fly, the center of gravity must fall within specified limits

3.15. Deciding the landing gear positions

Aircraft landing gear supports the entire weight of an aircraft during landing and ground operations. The design and positioning of the landing gear are determined by the unique characteristics associated with each aircraft, i.e., geometry, weight, and mission requirements.

4. Result

The team decided to build the prototype after a series of discussions and surveys which were further verified with mathematical analysis. The Test results obtained showed similarities with theoretical values. The prototype was further able to achieve flight at a desired altitude. The above study provides the answer to the question of limitation about the UAV platform, Performances are close to commercial ones with flight time of 60 min, up to 2000 pictures per flight, and maximum weight at take-off (MTOW) of 2kg. Platform will be accurate enough for precise DTM in areas with vegetation, after the range sensor will be changed to true RADAR. More experiments are needed in order to accommodate us with the flying wing and software parameters, in order to find the optimum relation between terrain and flight.

5. Working

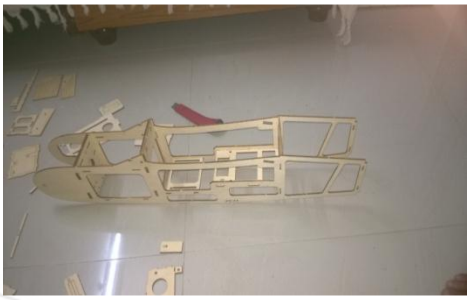
- Signal inputs are given from the transmitter to the onboard receiver
- The receiver converts the input signals into mechanical output
- Initially the motor generates enough thrust for the aircraft to take off from the ground
- Once the main landing gear loses the contact with the ground surface the controller starts wing corrections with the help of ailerons
- After the aircraft gains enough altitude it
  Is leveled off and bought into the cruise phase
- After achieving the objectives of the flight, the aircraft is bought in to a halt by landing procedure.

6. Fabrication

Assembled Wing with 4^o Dihedral

Fuselage & Tail Assembly

Wing with Waterproof Covering



Fuselage Structure before Assembly

Ribs Alignment

Servo Mounting

Assembled Wing

7. Future Scope

- **Future developments in R&D level with less investments:**

In general, the efforts of designing automatic flying capabilities (including the related hardware), building integrated platforms to manage drone flights and also to analyze information captured via drones. These efforts have attracted significant capital in defense, R&D programs and private investments. The developments of these industry players in producing leisure, military, government/civil and commercial drone products and services are further supported by national and regional authorities focusing on safety issues and traffic management

- **Creating opportunity for various system**

The role of drones is likely to expand still for many years, thus driving the need to understand mission types that are being established today and also those yet to come. To examine different mission types and provide new insight into the rationale, as well as benefits and parameters for growth.

- **Automation**

The increase of automation up to potential of robotics in our skies is not brand new; however more robust technology is still required before many applications are commercially viable and accepted. Additionally, regulation and societal concerns related to privacy and safety remain constraints for some applications already feasible from a technical perspective.

- **Artificial Intelligence**

Current research efforts are looking at advancing the UAV to full autonomous operation and flight. New applications of AI, which include Intelligent Agents, are providing new areas of research. This concept will still be a key component with systems designed for future use.

- **Amphibious capability**

This concept is to design and perform flight-testing of a small, unmanned, amphibious demonstrator aircraft that flies autonomously from land or water airfield. Also the flight Avionics requires enhanced flight software to permit autonomous takeoff and landing from Water. The landing gear should be removed and floatation tests are to be conducted to verify that the aircraft has a proper water line and no hull leaks.

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