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A Review Article on Design and Development of Radio-Controlled Airplane

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ABSTRACT: Nowadays, the application areas of the aerodynamics are widespread in transportation and travelling. Along with it, it also explores in surveillance of the nation. Many researchers and engineers are working to improve the efficacy and performance of the aircraft used in surveillance and supply of necessary material things. The paper overviews the state-of-art of the aircraft used for the above applications. The development and design status of the aircraft is further reviewed considering the various design parameters like aspect ratio, wing loading, dihedral angle,Lift coefficient and Drag coefficient, Wing's Lift Coefficient, Wing's Drag Coefficient, and Airfoil. These are the basic parameters that are responsible for the performance and function of radio-controlled aircrafts.

I. INTRODUCTION

The term aerodynamics deals with the study of motions and forces acting on the objects flying in and through the air. The object flying in the air and supported by the dynamic actions of the air on its surfaces or buoyancy is known as aircrafts. Especially, gliders, helicopters, and airplanes. While, radio-controlled aircraft also known as RC aircraft/plane is the object having no pilot and controlled by the remote having radio transmitter by an operator. Because there's no pilot in RC aircrafts, it is often referred as unmanned aerial vehicle (UAV) or Drone. It is the kind of flying robot that needs no runway for flying. It is widely explored for public and military applications. In addition, RC aircraft are essentially scaled up functionally model aircraft that serve a more utilitarian role than just for the enjoyment of flying remotely controlled aircraft that hobbyists are known to fly and build [1].

The RC aircraft was first implemented in research, the miniature planes were first developed as a study model for the aircraft under investigation to study the forces that operate on the newly developed models. The RC airplanes were used during World War II for the target practice of military aircraft. The full-scale aircraft and RC Aircraft are similar to the aerodynamic study of the aircraft. Airplane boarding, Reynolds number, and the moments of inertia are the only difference between the full-scale and the RC aircraft that were further clarified [2].

Usually, RC models have wing loads of 1-3 lb / ft2, compared to a full-scale aircraft of 10. The RC model normally contains Reynolds Numbers below 500,000, while Full-Scale Aircraft number exceeds 1 million Reynolds. Moments of inertia in the R / C model would be much lower than the aircraft [2].

1 Basic Design Parameters

1.1 Wing loading

The wing loading is said to be the amount of load borne by each unit of its wing area, according to aerodynamics. If a fuselage is attached with a smaller-sized wing then the amount of load borne by each unit wing area further causes instability, the load distribution on the wing-surface is decreased if a larger wing is used and a much more stable flight can be achieved. Wing load is expressed for model aircraft ounce per foot (oz / ft2). for model aircraft.

Wing Loading (oz/sq.ft) = Weight (oz) / Wingarea(ft) (1)

1.2 Dihedral Angle

The dihedral angle is the angle between the x-y axis and the middle of the wing. The right and left portions of a wing shall have the same dihedral angle in order to achieve aircraft symmetricity. The goal of dihedral is to ensure flight stability.

If the angle is higher than that of "x-y" is known by the term "positive dihedral" or "dihedral". However, if the angle is lower than that of "x-y" [wing] then it is known as "negative dihedral" or "anhedrals" (wing tip).

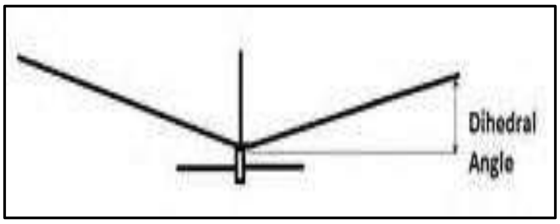

Figure 1: Dihedral Angle

1.3 Aspect Ratio

The aspect ratio shows the wings' overall efficiency. The length and the slenderness of the wings are measured. The aircraft wing in "high" aspect ratio is long and narrow wings, while the "low" aspect ratio is broad and stubborn. The high aspect ratio wing produces more elevation than the low aspect ratio, as the angle of attack is increased.

Aspect ratio = wing span^2 / wing area (2)

1.4 Lift coefficient

The lift force is dependent on the density of the air r, the airspeed V, the wing's Lift Coefficient and the wing‟s area according to the formula

Lift Force = 0.5 * r * V 2 * Wing's Lift Coefficient * Wing's Area (3)

1.5 Wing's Lift Coefficient

It is the wing is dimensionlessnumber depending on the type of airfoil, number of Reynold (Re), and the aspect Ratio (AR), and proportional toAttack Angle (alpha) before the stallAngle.However, the generation of the wing lift still generatesDriven drag which are forces along withparasite dragthat oppose the movement of the aircrafts by air.The density of the induced dragdepends also on-air r, air velocity V, Drag Coefficient of wing andWing's formula-specific region:

Drag Force = 0.5 * r * V 2 * Wing's Drag Coefficient * Wing's Area (4)

1.6 Wing's Drag Coefficient

It is also the dimensionless aspect similar to lift coefficient that depends on shape of the wings, aspect ratio, attack angle, and Reynolds number. The characteristics of any particular airfoil can be demonstrated by graphs that display the lift-drag volume achieved at different angles and the lift / drag ratio. The same airfoil has different lifting and drag coefficients in various Reynold numbers as shown in Figure 2.

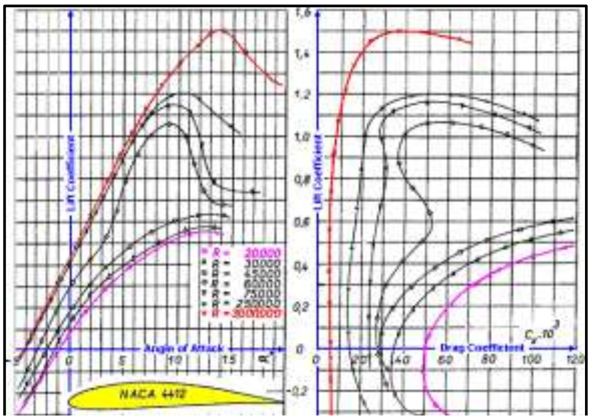

Figure 2: Lift coeeficient vs angle of attack and drag coeeficient

1.7 Airfoil

A special form called an airfoil is an aircraft wing. The air is separated and travels above and underneath the wing as a wing moves through the air. Depending on the model 's specifications, the wing upper or lower surface is formed in a curve. This form of the curve causes the air to rush up and expand over it. The air pressure on the curved portion of the wing is decreased [3].

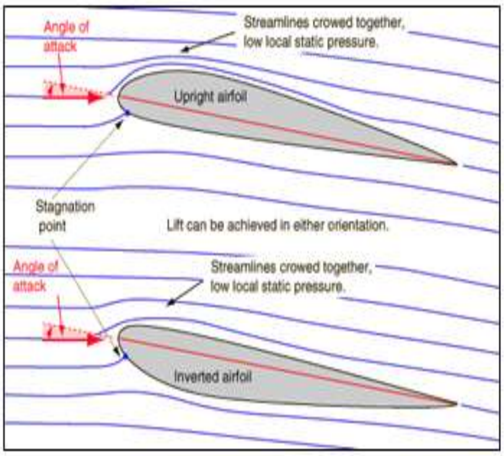

Figure 3: Angle of attack against the upright & inverted airfoil

II. LITERATURE REVIEW

There is one fundamental aspect of each smart city that is the technical capacity and also technological perseverance, in the twenty-first century, the majors for this aspect are the importance of UAVs (Unnamed aerial vehicles) and MSPs(Mobile sensing platforms). [19]

Bryan Stafford[1] has done an experimental study on 1/8th scale models of steel frames infilled with mortar subjected to bias load

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and he concluded that a bias tensile failure or a compressive failure occurs in the mortar infill. He derived an equation for loading capacity, and also derived an expression for struts.

May and Naji[1] have described a non-linear FEA (finite element analysis) program to simulate the cultists of steel frames infilled with the concrete panel. Numerical examples to validate the capabilities, limitations, and strengths of the program were described. In this model, eight nodded elements were used for panel and there are three nodded elements for beams and columns and also, they considered shear locking effects.

Abolghasem Saneinejadet al[1] presented a new method of analysis and design for steel frames with concrete or masonry walls pointed to in-plane forces. The method predicts the strength and stiffness of infill frames and the diagonal cracking load. The equivalent diagonal strut transforms the infilled frames into equivalent braced frames and provided adjustments are made for include the induced intermediate bending moments and sheer concentration due to the finite lengths of bearing of the infill into the frames.

Dubey and Deodhar[1] have present the effect of reinforcement on the ultimate strength of infilled steel frames subjected to loads. This study was based on experiments on eleven models of a single-story, single-bay portal frame infilled with plain concrete and with reinforced concrete. Reinforcement was provided in the form of a rectangular mesh made of 2 mm diameter high strength of steel. The value of reinforcement adopted was 0.15 and 0.2. There is **a**n analytical method was proposed to estimate their ultimate load. They proved that the reinforcement increases the ultimate load of the infilled frame and rectangular mesh type reinforcement is found to be effective than diagonal mesh.

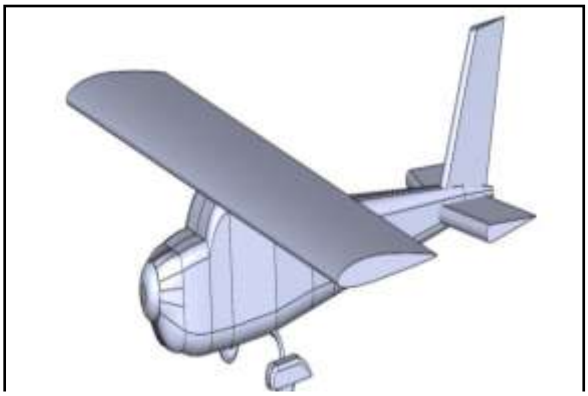

Figure 4: Solid model of RC aircraft

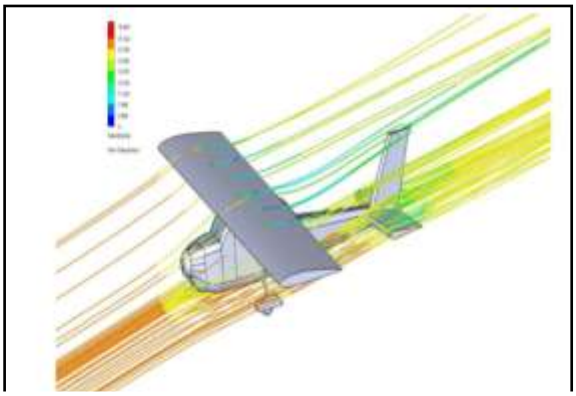

Figure 5: WingAnalysis

Khalid M. Mosalamet al[17] had done the experimental investigation of gravity load designed steel frames (i.e) steel frames with semi-rigid connections, infilled with un-reinforced masonry walls and subjected to slowly applied cyclic lateral loads. Various geometrical configurations of the frame and the infill walls and different material types of the masonry walls were considered. Based on the results, a hysteresis model for infilled frames was formulated.

Roger D.Flanaganet al [18] shows several bi-directional experiments with the structural clay tile infilled steel frames to assess the interaction of in-plane and out-of-plane forces and to understand the cultists of damaged infill. Infill panels prooved sufficient out-of-plane stability under the internal loads as well as imposed drift loads. The foremost effect of sequential loading was a get reduce of in-plane stiffness because of the diagonal cracking limit state. They concluded that under combined in-plane and out-of-plane loading the infill remained remarkably stable, even after much damage to the masonry panel.

Ibrahim Gov et al [16]shows in a research article that the lift force and drag force of an RC airplane is calculated by the use of computational fluid dynamic (CFD) analysis. NACA 2412 airfoil is used in wing design. Flow trajectories of velocity and pressure on an airplane are given at different values. After this study, it is shown that both drag force and lift force values are increased due to increment in other values.

Prada SV et al[1] have made the experimental project work that deals with “Design, Fabrication & Analysis of a High Winger Conventional tail RC airplane”. An analysis is done on the Aircrafts wing using Design Foil software & they choose airfoil is NACA-0018. In this research article, the Comparison is done between Theoretical calculations, and the values show in designfoil software. As per analysis results, the value of the lift obtained from the software is nearly equal to that of the calculated value. With the validation, the aircraft design has flown successfully.

Figure 7: Real model of RC aircra

T. Narendiranath Babuet al[14] performs an analysisbased experiment. fluid dynamic analysis and pressure distribution analysis are performed using the finite element method for the Remote Controlled (RC) aircraft wing. And they concluded that the selection of airfoil, choosing the right thrust, wing dimensions, calculation of lift and drag forces a wing which is optimum for a small, slow-flying RC airplane.

J.T.S.V sagar et al [13]construct a radio-controlled aircraft by wood. It emphasizes designing and constructing Radio Controlled Aircraft using balsa wood and all electronic components included controlling features. This RC aircraft can easily fly at a very high speed. And it can maintain constant lift after the take-off. This RC aircraft flies with a radius of 1 kilometer. Also, they have attached a camera on the bottom of the aircraft, So they get live data to any kind of base station like mobile, laptop, pc and also store in the cloud. This kind of aircraft used in military operations and also in some critical situations.

Andrew Deschenes et al[11] In this research article they described the design, construction, and testing of several types of RC aircraft that can be optimized maximum endurance and fulfill the requirements of both systems. There were multiple solutions such as obtaining more accurate materialistic properties for carbon fiber, weight-reducing holes, and testing so the structure can be reduced in design and engineered to the specified flight envelope of 1.5g. The wing was the heaviest component of the aircraft and they also reduced the weight of it.

Figure 8: control rods

S.R.premkartikkumaret al [10]In this research article they create over oven airfoil compare and contrast with the airfoils already being used and design., it is seen that it’s better than the already existing model. Airfoil compares and contrasts with the airfoils already being used and design so that it is better than the already existing model. Also, in this research paper the detailed compare/contrast between the currently used or commonly used high-performance airfoils and the airfoils that are designed by all.

Lungu M. et al[2] shows that adaptive architecture is software implemented and validated by complex numerical simulations. designed and software implemented all the components of the new landing system and obtained the time histories of the main variables; the obtained characteristics prove that the new architecture's stability and its small overshoots; there have been obtained better results than the ones in, especially due to the usage of the neural networks-based adaptive controller and PCH block.

Reece A. Clothier et al [3]prepared Barrier Bow Tie Model (BBTM). It is proposed as its focus on the risk analysis, evaluation, and decision-making activities on the practical devices, people, and processes that can be used to reduce risk. Existing literature and practical controls were reviewed and used to define the components of the model and a case study is used to exemplify its application.

Alok Sinha et al[4] show the changing landing gear and controller, landing gear, and CCD3 controller. And proved that Using landing gear our system doesn’t need any external force for flying. According to the study the CCD3 in a low-cost controlling unit. This work is prepared to design an RC aircraft or drone that will try to stabilize its position according to preferred altitude.

Muhammad Ahsan Iqbal et al [5] For power saving of RC aircraft, battery requirements, weight & payload, the surface area can be changed. RC surveillance aircraft was used as the reference prototype and was accordingly modified with

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renewable sources to be self-powered. The cross-sectional area was found for the aircraft wings, and the number of PV cells that can be accommodated under this area were found approximately to be 60 PV cells.

Şeyma Akyürek et al[6] proved that the aircraft dynamics are used to design the model of the control system in the MATLAB Simulink environment. one design approach of a flight stabilizer for fixed-wing aircrafts using loop shaping method and tested in X Plane flight simulation are outlined. The flight stabilizer's controller worked successfully.

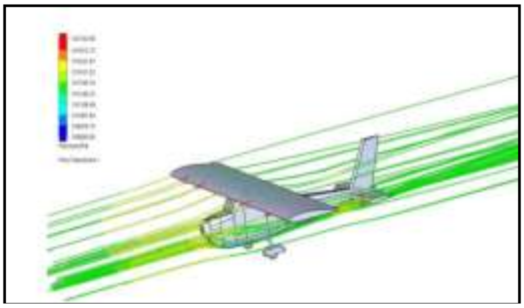

Figure 9: simulation of wings

Katherine C Stuckman et al[7] radio-controlled (RC) aircraft includes a receiver that is coupled to receive an RF signal from a remote-control device. A motion-sensing module generates motion data based on the motion of the RC aircraft.

Pradyumna S V et al[8] The paper deals with designing a radio-controlled aircraft by considering various parameters such as aspect ratio, taper ratio, power loading, etc. This project work deals with "Design, Fabrication & Analysis of a High Winger Conventional tail Radio controlled airplane". The project has been successfully carried out and also the 2D & 3D drawings of the Front view, Top View, and Side View are shown.

M.norsell et al[9] Investigates the implementation of the radar cross-section (RCS) of aircraft in modeling and simulation (M&S). Seven interpolation schemes were considered for the generation of continuous RCS samples, among them spline interpolation method was proved best for originating new data points with less interpolation error.

III. CONCLUSION

As affordable hardware is more available and more diverse and virtually all of its related sub-systems are working, and as costs and complexity to operate decrease massively, RC aircraft become a common feature in many applications quickly. In this paper, the design parameters and performance research of radio-controlled aircraft have been reviewed by the authors. Most of the researchers have concentrated on eight nodded element model. The methodology of Finite Element Analysis for linear and non-linear analysis was adopted. It was observed that by optimizing the design parameters, the performance of the radio-controlled aircraft can be enhanced.

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