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Design and Simulation of an Autonomous Drone for Agricultural Monitoring Using CATIA and ANSYS

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ABSTRACT: This project is all about creating a special kind of drone that can help farmers keep an eye on their fields more easily. Farmers need good data to make their farms work better, and drones can help with that.

First, we use computer programs like CATIA to design the drone. We think about things like how it flies, how strong it needs to be, how much it can carry, and how easy it is to fix. We make sure it's really good for flying over farms, even when the weather isn't perfect, and that it can move well in tight spaces. We also make sure it can work with different tools for sensing things in the fields.

Once we have the design, we use another program called ANSYS to test it out. We check if it can handle flying in different situations without breaking, and if it's good at staying stable and efficient. We also make sure it doesn't get too hot when it's flying for a long time by material varying steel, Aluminium, Carbon Fiber, Titanium Alloys and E glass are check with wing of drone. Then, we work on making the drone smart. We teach it to fly by itself, avoid obstacles, and follow instructions precisely.

KEY WORDS: DRONE, FARMERS, CATIA, ANSYS

I. INTRODUCTION

The current project “multi-purpose agriculture drone” is totally aimed to design, analyze and test a multi-functional drone for the agricultural uses to be submitted to a manufacturing company, according to the customer needs in a more optimized way. This internship was held mostly online by AIE company, located in Lugo, employing both employees, students and interns with different majors in different teams.

The ultimate purpose of developing the smart agriculture means and tools is to find an approach to meet the human needs as the global population is growing overwhelmingly. Furthermore, the protection of the environment is becoming



a vital issue during these industrialized years. In the following chapters, the environmental positive effects of agriculture drones will be pointed out.

The first question coming to minds is the definition of “Drone”. The word “drone” first appeared in the early 16th century to indicate a male honeybee. The honeybee drone has a single purpose, to fertilize a queen bee during a mating flight, followed by the death of the drone. After World War Two this concept was applied to coin a word for pilotless aircraft used for target practice—a mission with a single purpose involving the destruction of the aircraft. By the 1990s military unmanned aircraft had morphed into weapons systems used to remotely deploy munitions in conflict zones around the world, but they were still referred to as drones. Within the last decade the word “Drone” underwent another expansion in meaning, and is now used to describe both military and civilian unmanned aircraft, from toy remote-controlled quad-copters to sophisticated unmanned aircraft used in a wide range of commercial applications including aerial photography, surveying, infrastructure inspection, emergency response, package delivery, and agriculture. Prominent alternative terms commonly used in various parts of the world and different contexts include Remotely Piloted Aircraft (RPA) and Unmanned Aircraft Systems (UAS). Within the context of this chapter, a drone is defined as a remotely piloted aircraft controlled directly by a human operator via a radio link, or with various levels of autonomy achieved by using autopilot technology.

1.1 Types of drones:

Mainly 4 types of drones can be pointed out as fixed-wing, single-rotor, multi-rotor and hybrid. The pros and cons of each type are outlined in table 1.

Type	VTOL	Flighttime	Payloadcapacity
Fixed-wing	No	High	Medium-High
Single-rotor	Yes	Medium- High	Medium-High
Multi-rotor	Yes	Low	Low
Hybrid	Yes	Medium- High	Medium

Table:1 Typical characteristics of drone types

1.2 Differences in energy sources :

The other characteristic discussed here is the energy source. There are four main energy sources: traditional airplane fuel, battery cells, fuel cells, and solar cells. Airplane fuel (kerosene) is mainly used in large fixed-wing drones. An example of such a drone is the military Predator drone. This drone is used a lot by the US army and can be equipped with a number of different sensors, but also with rockets and other types of ammunition.

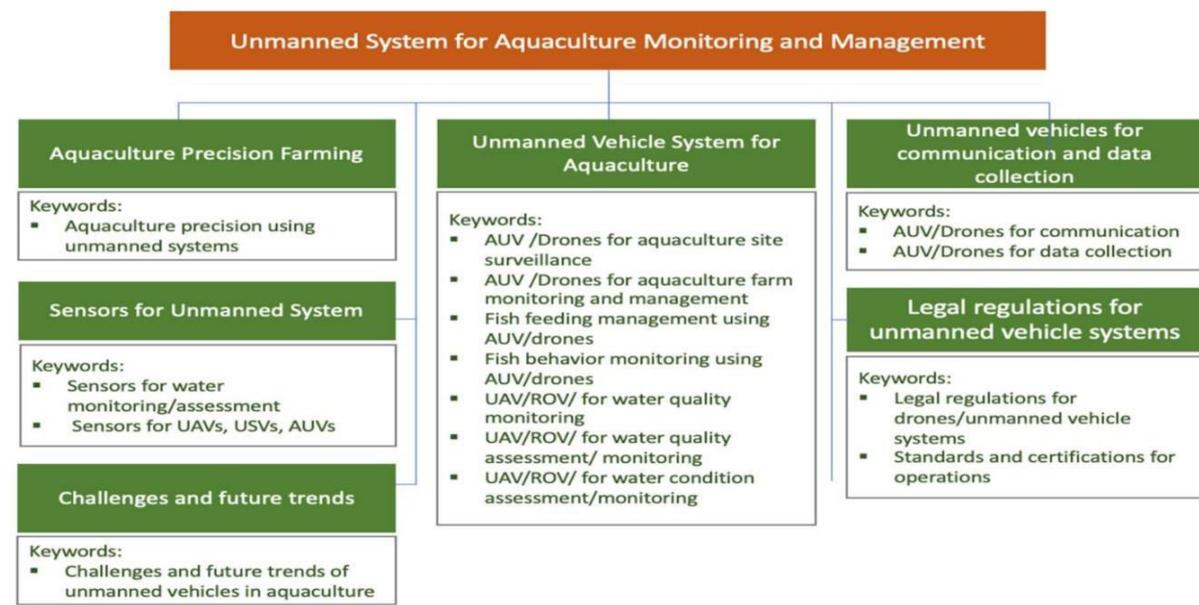
Battery cells are mainly used in smaller multirotor drones. These drones are short range and require less operating time than drones using kerosene. These drones are often for recreational use, making it more practical for the drone to run on a rechargeable battery cell. An example of such a drone is the Phantom drone.

A fuel cell is an electrochemical device that converts chemical energy from fuel directly into electrical energy. Because of the lack of conversions in thermic and mechanical energy, this conversion is efficient and environment friendly. Fuel cells are currently rarely used in drones. Only fixed-wing drones can be equipped with such a cell because of the cell’s relatively high weight. A major advantage of using a fuel cell is the fact that drones can fly longer distances without recharging. For example, the Stalker drone which uses a fuel cell has a flight time of 8 h instead of 2 h.

This paper’s purpose is to conduct a review of literature and studies conducted for unmanned systems’ applicability to

perform aquaculture monitoring and surveillance. The majority of the literature search was made using the Web of Science (WOS) database. Factors considered in the preference of articles include relevance to the related keywords provided for the search and the number of paper citations. There were no restrictions on the date of publication. Figure 1 is the taxonomy used for keyword extraction in the Web of Science database to determine the trend and the number of works involving unmanned vehicle systems for aquaculture. The authors also used Google Scholar, IEEE Xplore and Science Direct to search for related works.

Figure 1. Taxonomy for keyword extraction in the database search



Unmanned Vehicles and Sensors

Unmanned systems’ navigation and monitoring capabilities concerning several quantities in their environment strictly depend on their sensors, measurement systems, and data processing algorithms. Sensor fault detection is also essential to ensure safety and reliability. UVs have different numbers, types, and combinations of sensors mounted in various ways to measure information using specific, diverse, and customized algorithms. Therefore, finding an optimal sensor that can perform various tasks, applications, and types is an unsolvable problem. Individual sensor specifications and characteristics affect the performance of UV aside from other factors such as operating conditions and environment.

Abishini A, Priyanka Bas B, Raque Bertilla A, Haston Amit Kumar:

Drones have been implemented for several application around the world due to its robust technology and ease of operation. In this project we would like to implement drones for underwater as well as aerial surveillance at our coastline and further extend its application for detection of underwater air crashes and ship wrecks. Underwater drones must consider important factors such as floatability and buoyancy which challenges the structural integrity and power requirements of the drone. This project uses an innovational quadcopter design with a new streamlined structural geometry. The entire frame is designed using CATIA. The new design is validated for its successful implementation through stress analysis using ANSYS, also suitable material for fabrication is selected by comparing five other materials. [1]

Brijesh Patel, R. P. Sukhija, J. V. Sai Prassana Kumar:

A great development occurs due to the use of small unmanned air systems known as drones, Unmanned Aerial Vehicle (UAV) or Unmanned Aerial Systems. As this systems have many components where major research have been done which focuses on new applications of UAV’s, control optimization, Enhancement of Endurance Limit ,GPS, Autopilot etc. There is small research done on Structural Components of Hexarotor. In order to get High Endurance the structural Analysis has to perform. Multicopter possess a light weight frame, high thrust motor landing gear and a conventional structural arrangement There is a great need of structural analysis of arm of multicopter with motor mounted should be examined. Structural Vibration Analysis of Carbon Fiber Arm of Hexarotor, as due to high RPM of

Motors the arm is affected by many structural loads. This paper discusses the experimental and numerical vibration analysis of a Hexarotor Arm and subordinate structure. This research provides an analysis of the vibration sources affecting the Hexarotor and an experimental modal analysis of the carbon fiber arm of Hexarotor. The resulting data will provide the area of low vibration, which results the mounting of other instruments for better operation. [2]

Bruhn, E. F. (1973) :

Analysis and Design of Flight Vehicle Structures by E.F. Bruhn is one of the most useful Aerospace Industry and University text books ever written with the emphasis on practical application with input from both material strength and hands-on experience. It was originally published in 1965, and was revised in 1973. This book was prepared as a source of data and procedure for use in the sizing and design of both airframe and space vehicle structures and is the only book that has been widely used by the Aerospace Industry to date. The material presented herein has been compiled largely from the data of NACA reports and technical publications. Also there are chapters in this book that contain materials supplied to the author by well known flight vehicle structural experts from various universities and aerospace.

II. MODELLING

3.1 Introduction To Catia:

Program that can combine between drawing and design, animation and simulation production and Manufacturing, without need to use more than one program, to produce a single project, until found everything I need in the most comprehensive program on earth "CATIA". This program, which change my point of view in the science of mechanical drawing, where it became easier, more flexible and more accurate.

3.2 Module in CATIA:

CATIA consists of modules each Module specialized in specific design field, And I will review now the most famous of these modules

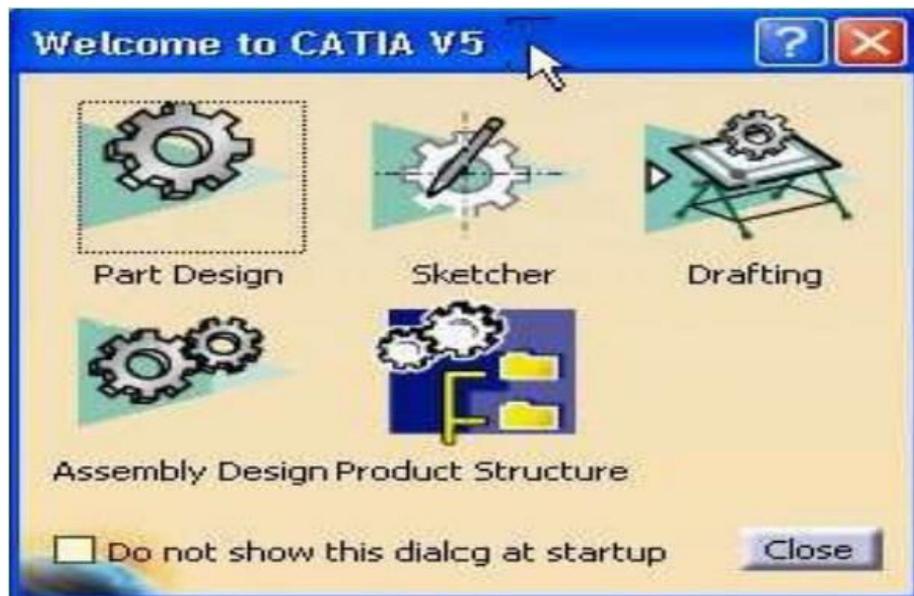


Fig 3.1 : Some of CATIA Modules

3.3 DESIGN OF AUTONOMOUS DRONE IN CATIA

The design of entire autonomous drone is carried out using CATIA V5 R20 software. The steps involved in designing the model is explained briefly.

Assembly design and their parts of the autonomous drone:

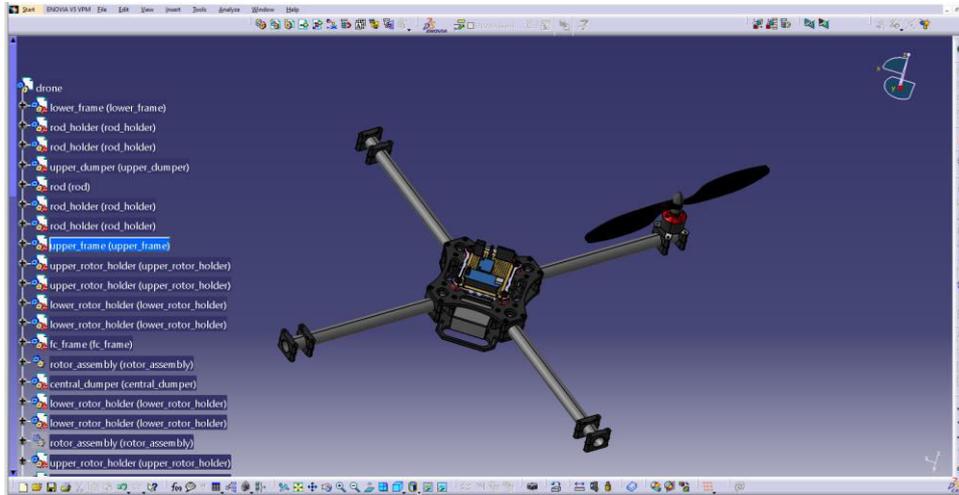


Fig 3.2 Design of Autonomous Drone Using Catia

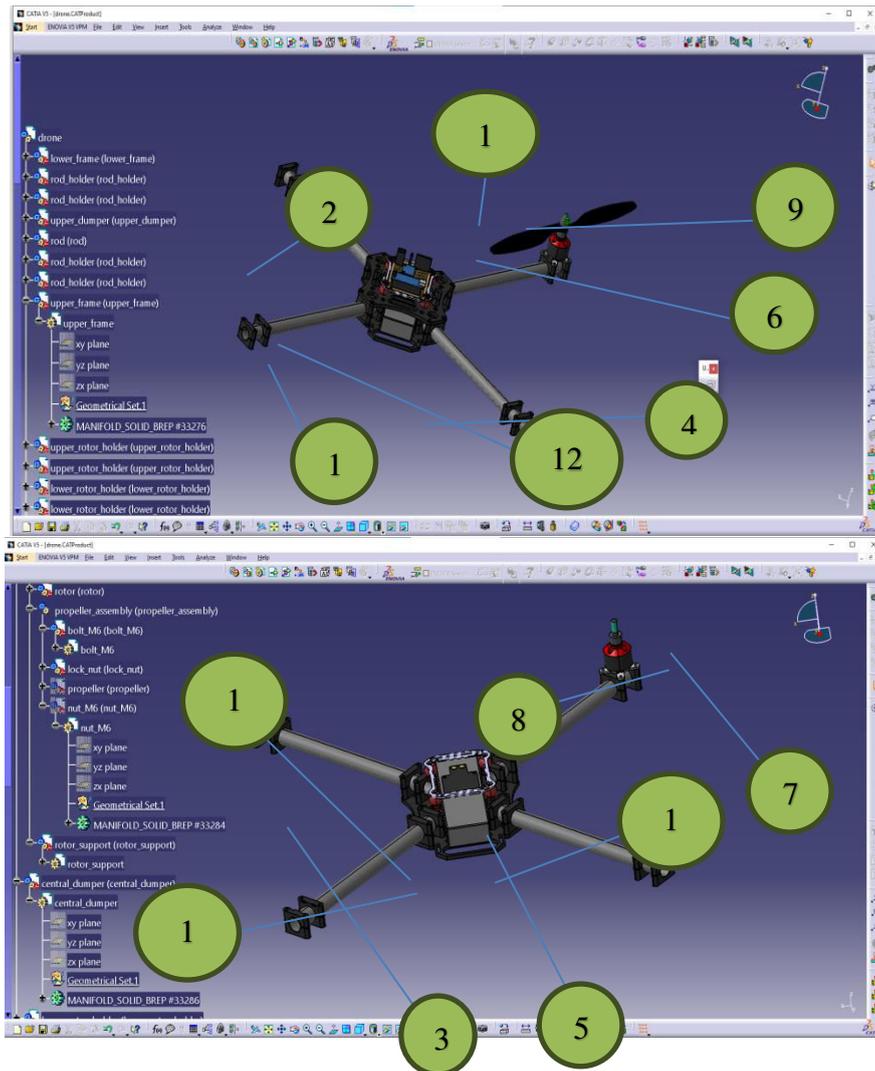


Fig 3.3 Parts of Drone

3.3.1 LOWER FRAME:

Step 1: Open CATIA V5 R20 > Start > Mechanical Design > Part design > Specify the file name as **LOWER FRAME** >ok.

Step 2: Select XY Plane > Click on Sketcher tool to open Sketcher module.

Step 3: Draw the sketch shown in the figure using profile tool. Once the outer closed profile is created, specify the dimensions as given in the figure by using constraint tools available in constraint toolbar.

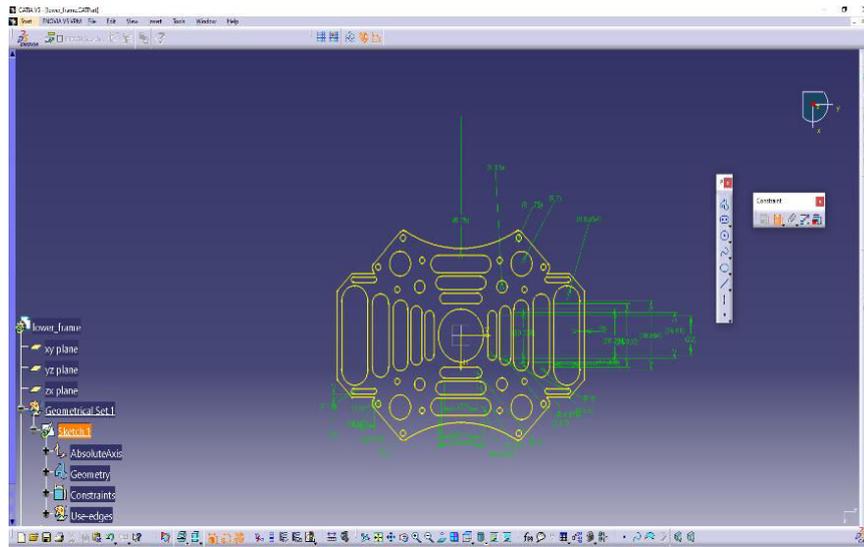


Fig 3.4.1 Sketcher for Lower Frame

Step 4: Go to Sketch based features > Pad > Specify the pad length as 2m > Enable Mirrored Extent > OK.

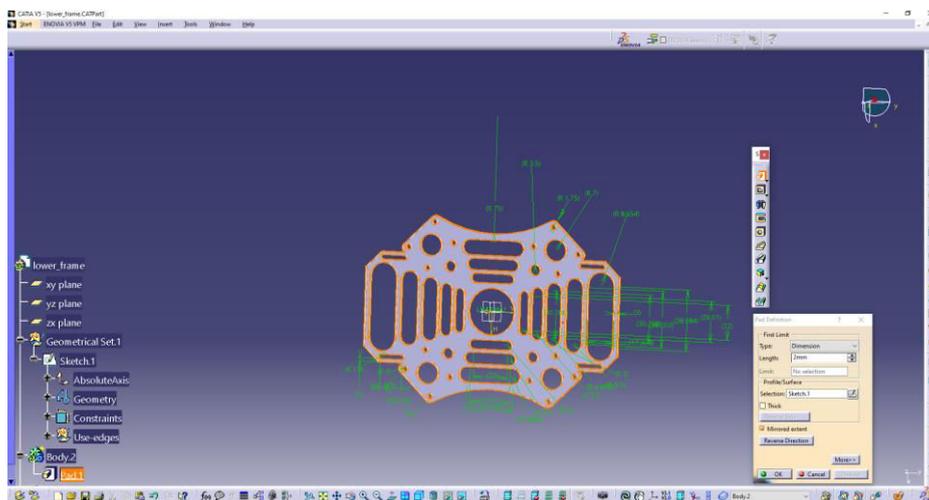


Fig 3.4.2 Part Design for Lower Frame

IV. ANALYSIS & GRAPHS

Steps in Finite Element Analysis:

STEP 1: First the domain is represented as finite elements. This is called discretization of domain. Mesh generation programs called processors, help in dividing the structure.

STEP 2: Formulate the properties of each element in stress analysis. It means determining the nodal loads associated with all element deformation stress that is allowed.

STEP 3: Assemble elements to obtain the finite element model of the structure.

STEP 4: Apply the known loads, nodal forces in stress analysis. In stress analysis the support of the structure has to be specified.

STEP 5: Solve simultaneous line algebraic equations to determine nodal displacements in the stress analysis.

STEP 6: Postprocessors help the user to sort the output and display in the graphical output form. A typical finite element model is comprised of nodes, degrees of freedom, elements material properties, externally applied loads and analysis type. The finite element method is a numerical analysis technique for obtaining approximate solutions to a wide range of engineering problems.

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software Implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated, or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

The structural analysis applies applied mechanics, materials science, and applied mathematics to measure a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The analysis results verify a structure's fitness for use, often precluding physical tests. This report presents the results of structural analysis of the Agricultural Unmanned Aerial Vehicle in compliance with the requirements of DGCA. The analysis includes the Strength of Materials approach to determine loads (Shear Force and Bending Moments) which is utilized for further analysis using the Finite Element Analysis (FEA) approach. Commercial FEA software ANSYS is used for this purpose. The static structural analyses of the UAV are performed under different load conditions. The consequences of these researches show that the planned construction is safe within the flight envelope. This paper lays the structural analysis framework, which could as a source for additional temporary separation. To mimic real-time events. This paper is required to showcase the structure's authenticity (hypothetical load circumstances compelling) for certification determinations and vibration endorsement from DGCA. Material changes are made on wings of drone Steel, Aluminium, Carbon Fiber, Titanium Alloys and E glass

The Catia V5 assembly file to converted on to Ansys file (IGES) the below fig 4.1 shows

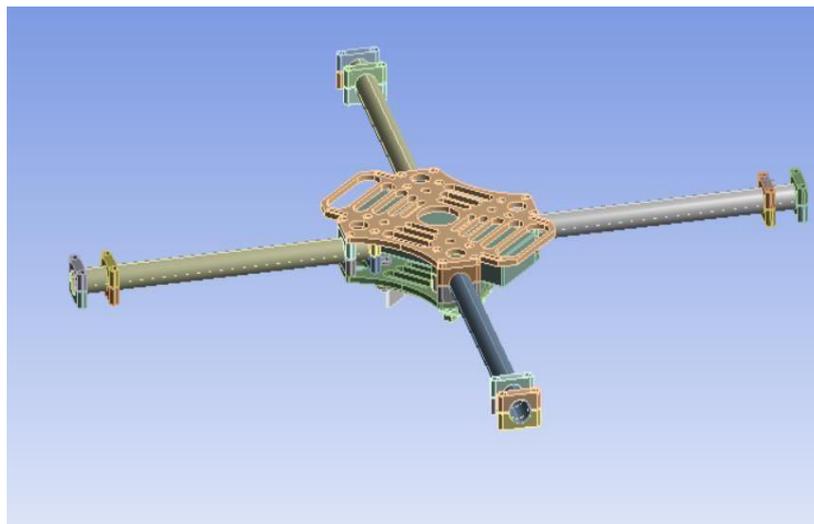


Fig 4.1 Model Imported Into Ansys

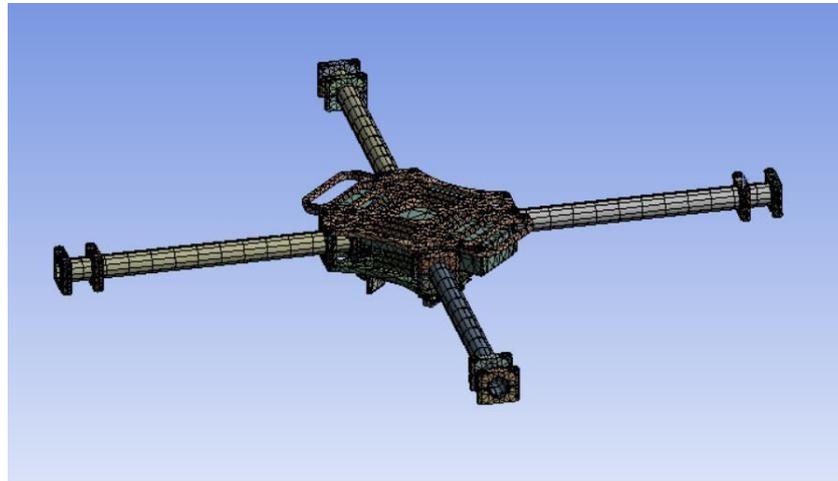


Fig 4.2 Mesh Model Drone Ansys

4.3 Structural Analysis on Drone:

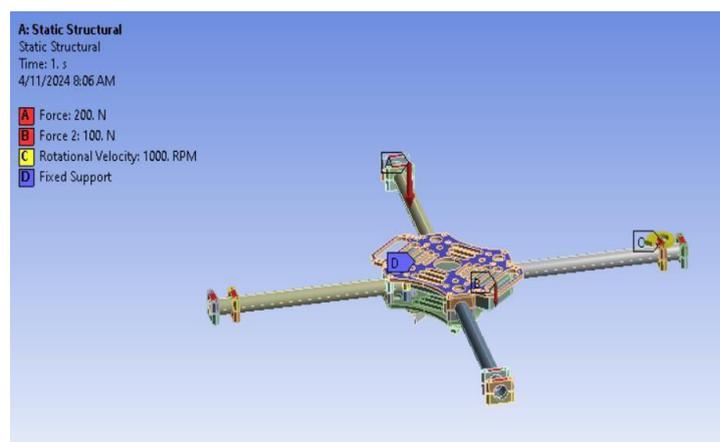


Fig 4.3 Load and Boundary condition applied to Object

4.3.1 Wing Material: Steel

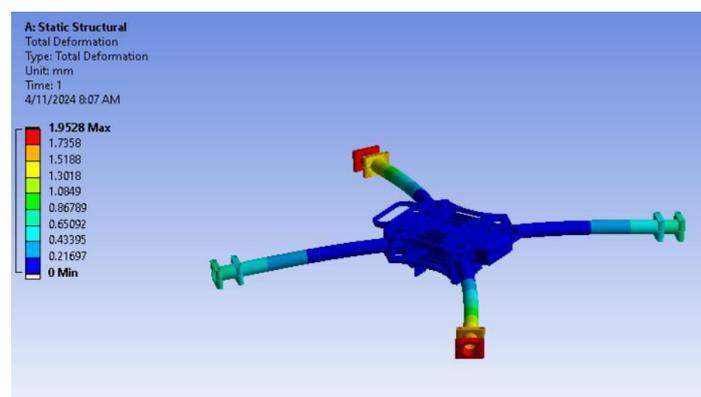


Fig 4.4 Deformation of 1.95mm



V. RESULTS

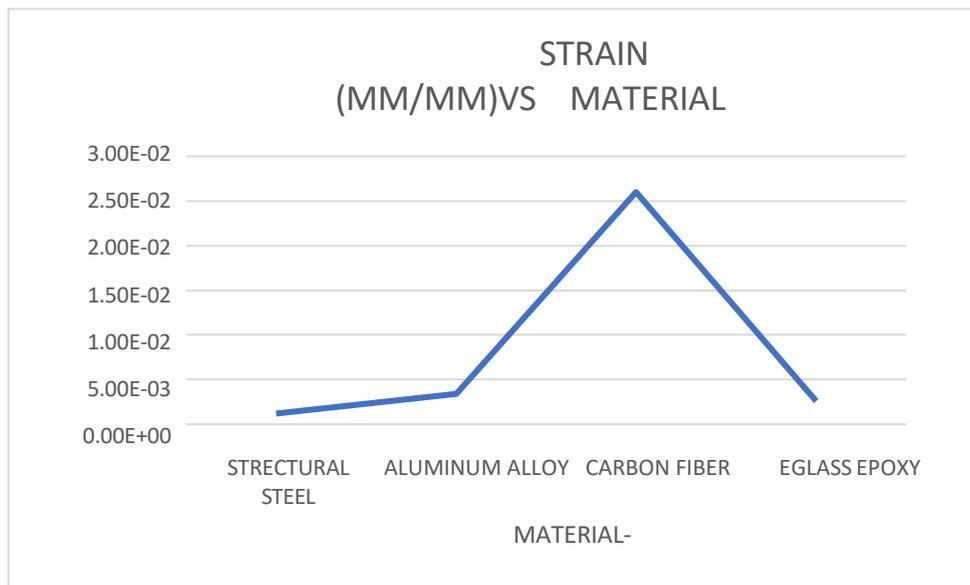
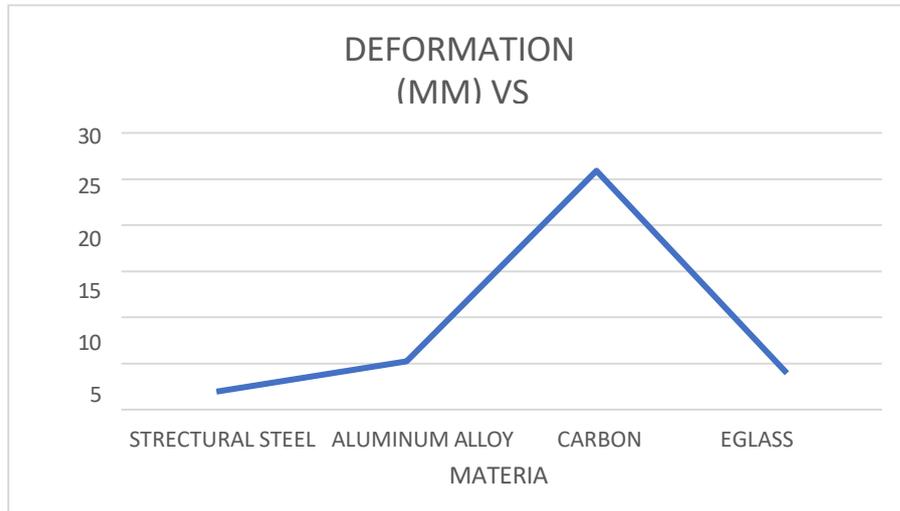


TABLE 1

SNO	MATERIAL	DEFORMATION (MM)	STRESS (MPA)	STRAIN (MM/MM)
1	STRUCTURAL STEEL	1.95	257.31	1.20E-03
2	ALUMINUM ALLOY	5.25	243.52	3.40E-03
3	CARBON FIBER	25.9	391.91	2.60E-02
4	EGLASS EPOXY	3.92	247.96	2.60E-03

VI. CONCLUSION

The UAV was initially analysed using the Mechanics of Materials approach. (Shear Force and Bending Moment Calculation). The results obtained from the MOM approach were used as the input to the Finite Element Analysis carried out using ANSYS (Static Structural) for the complete UAV. From the results obtained using the approaches above, we infer that. The physical behaviour of the UAV in terms of its deformation behaviour (static) satisfies by varying material to Wing pipe materials as Steel, Aluminium, Carbon Fiber, Titanium Alloys and E glass are varied

From the total deformation results obtained in ANSYS, we inferred that the deformation for the complete UAV was within the negligible limits, demonstrating that the air frame structure shall be able to withstand flight limit loads without failure, malfunction, or permanent deformation. Thus, it satisfies the DGCA requirement, Therefore E-glass is much better than Carbon Fiber and Aluminium for design load carry.

REFERENCES

1. Abishini A, Priyanka Bas B, Raque Bertilla A, Haston Amit Kumar: Design And Static Structural Analysis Of An Aerial And Underwater Drone :: e-ISSN: 2395-0056 p-ISSN: 2395-0072: International Research Journal of Engineering and Technology (IRJET)
2. Brijesh Patel, R. P. Sukhija, J. V. Sai Prassana Kumar: Structural Analysis of Arm of Multicopter with Various Loads.
3. Bruhn, E. F. (1973). Analysis and Design of Flight Vehicle Structures.Indianapolis: Jacobs.
4. Mogili, U.R.; Deepak, B. Review on application of drone systems in precision agriculture. Procedia Comput. Sci. 2018, 133, 502–509.
5. N.V.Divya, Syed Rizwan: Analysis of Plates by using ANSYS.
6. P.V.Sawalakhe, J.A. Shaaikh: Simulation and Analysis of a Quadrotor UAV while Landing.
7. Puri, V.; Nayyar, A.; Raja, L. Agriculture drones: A modern breakthrough in precision agriculture. J. Stat. Manag. Syst. 2017, 20, 507–518
8. Rahul Singha, Rajeev Kumara, Abhishek Mishrab, Anshul Agarwal: Structural Analysis of Quadcopter Frame.
9. S.R.Kurkute, B. D. Deore, Payal Kasar, Megha Bhamare, Mayuri Sahane: Drones for Smart Agriculture: A Technical Report: International Journal for Research in Applied Science & Engineering Technology (IJRASET): ISSN: 2321-9653; IC Value: 45.98; Volume 6 Issue IV, April 2018.
10. Yong-Bin Park, Khanh-Hung Nguyen, Jin-Hwe Kweon and Jin-Ho Choi: Structural Analysis of a Composite Target-drone: Technical Paper Int’l J. of Aeronautical & Space Sci. 12(1), 84–91 (2011): DOI:10.5139/IJASS.2011.12.1.84 N. S.L. Yang, X.B. Yang, J.Y. Mo, Prec. Agric. **19**, 278 (2017).
11. S.L. Yang, X.B. Yang, J.Y. Mo, Prec. Agric. **19**, 278 (2017).
12. S.K. Phang, K. Li, K.H. Yu, B.M. Chen, T.H. Lee, Unmanned Sys. **2**, 121 (2014).
13. K. S. S. Gurudatta, V. Harikiran, M. V. D. K. Raju, B. Rama Krishna & I. Jagadeesh"Design and CFD Analysis of Drone Thrust with Duct"https://doi.org/10.1007/978-3-031-15175-0_44 ,07 June 2023 ,pp 545–561S.K. Phang, M.A. Hassan, Z.Y. Wong, Z.Y. Ng, Y.L. Lai, J. Adv. Res. Dyna. Contr. Sys. **10**, 1379 (2018)
14. S. Guo, J.Y. Li, W.X. Yao, Y.L. Zhan, Y.F. Li, Y.Y. Shi, “Distribution characteristics on droplet deposition of wind field vortex formed by multirotor UAV”, PLoS ONE (2019)
15. IATA, “Best Practice for Component Maintenance Cost Management”, International Air Transport Association,3(2015).



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