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Design and Analysis of Quad copter

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ABSTRACT : A Quadcopter is an elegantlysimple design and is hands down the most popular layout for a whole lot of reasons. Quadcopters are symmetrical and embody the simplest principle of operation for controlling roll, pitch, yaw and motion. Experience gained in modifying and implementing a quadrotor, an Unmanned Aerial Vehicle (UAV), is presented. This project uses an innovational quadcopter design with a new streamlined structural geometry. The entire frameis designed using Fusion 360. The new design is validated for its successful implementation through stress analysis using Fusion 360, also suitable material for fabrication is selected by comparing five othermaterials.

KEY WORDS : Quadcopter, Static Structural, Constraints,StructuralGeometry,Design, Analysis

I. INTRODUCTION:

Drones are now being implemented in various fields such as agriculture, mining, surveillance, mapping, reconnaissance, etc. The versatility of drones has been expanding due to the highly advanced electronics available today. Imaging sensors, thermal sensors, passive infrared sensors, obstacle detection are some of the most commonly used ones today. Infrastructure surveillance and maintenance is done with less use of manpower using drones. Critical structures that require a lot of energyand time for inspection such as cable towers, wind mills, solar farms, industrial buildings walls and dams, can be easily inspected with the help of drones. This paper uses a new streamlined geometry which has been designed to be fully sealed to carry the components and all the circuits. This is done in order to fully protect the circuits. The model will be designed based on a basic quadcopter. The frame size, position and angleofarmswillallbedecidedbasedonthe propeller size to prevent interference between propellers and with the propeller and the frame.The entire frame will be modeled using Fusion 360.Using the chosen material's properties the weight of the structure will be estimated. The structural stability of the drone plays an important roleasitsapplicationinvolvesexposuretodifferent pressure environments. The stability of the frame will thus be validated using analysis through software.Theentire frame ofthedroneissubjected to static structural analysis using Fusion360.

Figure1 :Quadcopter

II. PROBLEMDEFINITION:

The main requirements for a drone to be able to travel in air is to have the ability to withstand thepressures which will be experienced in air and the electronic components should alsonotbe exposed to the atmosphere asitmaydamage it. So the design should be made in such a way that the electronic components like ESC, FC, battery, etc., are not exposed to atmosphere and the frame should be able to withstand air pressure till certain height. Testing quadcopter every time is costly affair hence numerical simulation provides the better and cheap way todesign.

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III. ANALYTICALMETHOD:

- **Design of the Frame** : The drone wasdesigned using Fusion 360 software by taking the missionrequirementsintoconsideration.Theframe and component traypart of the frame was designed separately and they are to be attached with screws. The motors for operation of the drone will be fit securely within the motor holders which were alsodesigned.

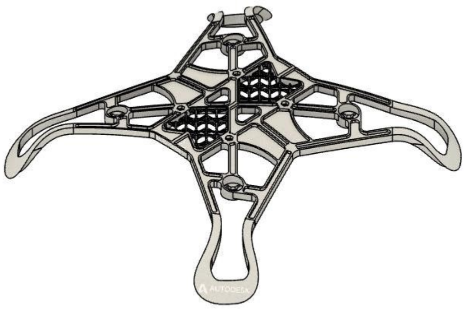

Figure2:Frame

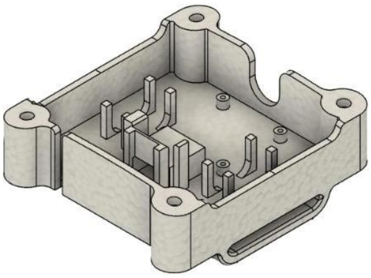

Figure3:ComponentTray

- **Material Selection :** Depending upon the usage material is selected, Various materials possess variousproperties. The most common used materials in the drones are CFRP, ABS Plastic, Aluminium AlSi10mg, Polystyrene, Nylon6,6.

S. No.	Material	Weight Estimation of Quadcopter(gm)	Density of the material(gm/cm^3)
1.	CFRP	408.986	2.0
2.	ABSPlastic	303.164	1.08
3.	Aluminium AlSi10Mg	763.632	2.69
4.	Polystyrene	292.011	1.06
5.	Nylon6,6	323.184	1.31

Table1:Materialand Properties

- **Static Structural Analysis:** Astatic structural analysis determines the displacements, stresses, strains, and forces in structures or components causedbyloadsthatdonotinducesignificant inertia and damping effects. Steady loading and response conditions are assumed; that is, the loads and the structure's response are assumed to vary slowly with respect totime

- **LoadCase:**
- Load : Due to the static condition the quadcopter located on the ground has to move towards the thrust direction produced by themotors. So the load at each entity can be of 340 gramsincludingbatteriesandelectroniccircuits.So each entity has a load of3.3354N.
- Constraint:Thequadcopterwhichislocatedon the ground due to the static condition the component tray is said to befixed.

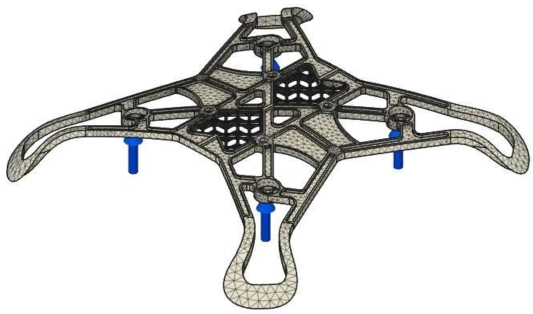

Figure4:MeshedFramewithload

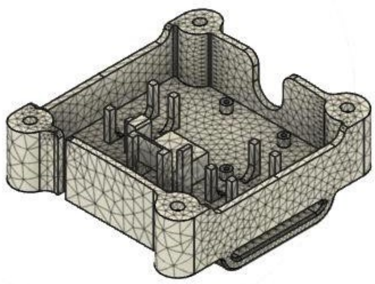

Figure5:MeshedComponenttraywith fixedconstraint

Component	Weight(gm)
Frame and Component tray	350
Battery	260
Motors	120
ESC and Flight Controllers	300
Propellers	24
CameraandCircuits	250

Table2:WeightEstimation

IV. RESULTANDDISCUSSION

Thetotaldeformation,reactionforces, contactpressures,principalstresses,fortheabove

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mentioned loading conditions and materials were obtainedusingstructuralanalysistoolinFusion 360 . The deformation results are shown in the figures below. The deformation values are shownin table3.

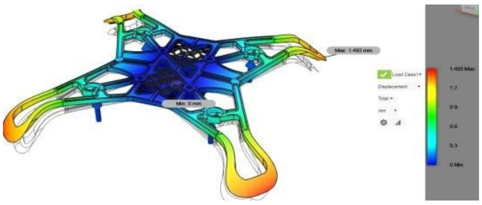

Figure6:ABSPlastic-TotalDeformation. Figure 7 : Aluminium AlSi10Mg-Total Deformation

Figure8:CFRP-TotalDeformation

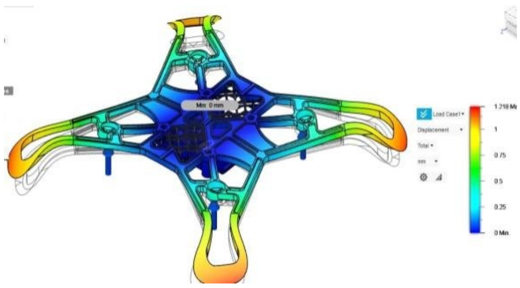

Figure9:Nylon6,6-TotalDeformation

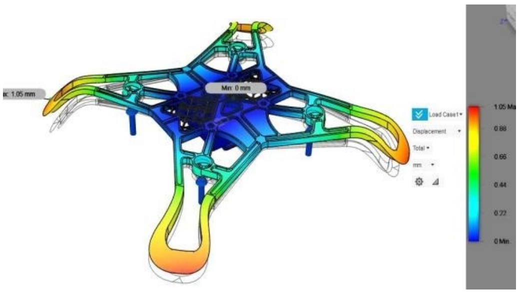

Figure10:Polystyrene-TotalDeformation

S. No	Material	Total Deforma -tion (mm)	Contac t Pressur e (Mpa)	React- ion Force (N)	Vonmis esStress (Mpa)
1.	CFRP	0.025	2.549	0.5155	5.748
2.	ABS Plastic	1.493	2.507	0.5031	5.749
3.	Alumini um AlSi10M g	0.047	2.331	0.5027	5.771
4.	Polystyre ne	1.05	2.406	0.4997	5.758
5.	Nylon 6,6	1.218	2.395	0.5089	5.759

Table3:DeformationValues

V. CONCLUSION

Thecenterofgravitywascalculated andit was found to satisfy the balancing condition forthis case. From the total deformation results obtained in Fusion 360 we inferred that the deformationforallthechosen materialswas within negligible limits. Therefore the most suitable materialwas chosen based on the weight of the frame. Since polystyrene gives a lighter structure compared to the others it was chosen forfabrication ofthe drone. Polystyrene not only gives a lighter and stronger structure, it additionally proves to be corrosionresistant.

VI. FUTURESCOPE

- The model will be fabricated with the chosen material and subjected to flight tests in air and water.
- GPS technology with geometrical reasoning can be implemented to remove limitations due to remote operation.
- Improvedunderwaterimagingcanbeprovided with acoustic imaging.

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