# DESIGN, ANALYSIS & FABRICATION OF PICK AND PLACE QUADCOPTER

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**Abstract:**The aim of the work is to make a carriage quad copter which is helpful in picking up and placing the products or objects from one place to another by the action of an external gripper which will be attached to the quad copter. An issue with drones today is that they are limited in their uses. Designing a drone capable of picking up objects would allow drone enthusiasts the ability to give drones a bigger impact on our everyday life. Our solution to this problem is to attach a gripper to a customized drone that allows it to pick up objects. Quad copters have generated considerable interest in both the control community due to their complex dynamics and a lot of potentials in outdoor applications because of their advantages over regular aerial vehicles. The main objective of the work is to deal with the design analysis and fabrication of the "Quad copter" which is manufactured for shifting the affordable objects which the quad copter have the tendency to pick and place. The regular design of the quad copter is modified and the static analysis is done on frame .The frame material is chosen as glass fiber and carbon fiber, So as to compare the values and the appropriate frame material is selected, And to sustain the loads generated in these vehicles .With the advancing drone technologies and increasing commercial usage, deliveries through drones or quad copter will soon become the next source for shipment.

**Keywords: Electronic speed controller, Frame, Gripper**.

## 1. INTRODUCTION

A Quad copter, also called a Quad rotor helicopter or Quad rotor, is a multi-rotor helicopter that is lifted and propelled by four rotors. Quad copters are classified

as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors (vertically oriented propellers). Unlike most helicopters, quad copters use two sets of identical fixed pitched propellers; two clockwise (CW) and two counter-clockwise (CCW). These use variation of RPM to control lift and torque. Control of vehicle motion is achieved by altering the rotation rate of one or more rotor discs, thereby changing its torque load and thrust/lift characteristics. There are several advantages to quad copters over comparably-scaled helicopters. First, quad copters do not require mechanical linkages to vary the rotor blade pitch angle as they spin. This simplifies the design and maintenance of the vehicle. Second, the use of four rotors allows each individual rotor to have a smaller diameter than the equivalent helicopter rotor, allowing

them to possess less kinetic energy during flight. This reduces the damage caused should the rotors hit anything.

## 2. Quad copter Motions

A Quad copter is a quad rotor helicopter which is having the four motors, but it is entirely different where as the lift force is produced by the four motors. The similarity exists between the helicopter and the quad copter is the vertical takeoff and landing. These quad copter are controlled by using a remote control for that reason they can be used in three area such as military to do spying on enemy camps, to avoid loss of man power these are unmanned aerial vehicles[1] ; These quad copter are classified into two types micro air vehicle and mini air vehicles this classification mainly depending on the size and weight of the quad copter. Each rotor has its own significance in creating thrust, torque and direction. The propellers which create the thrust to the quad copter is not alike two of them are clock wise act as pullers and other two are anti clockwise act as pushers. As consequence, the resulting torque is 'Zero'. In order to define an aircraft's orientation (or attitude) around its center of mass, aerospace engineers usually define three dynamic parameters, the angles of yaw, pitch and roll as shown in the figure1.

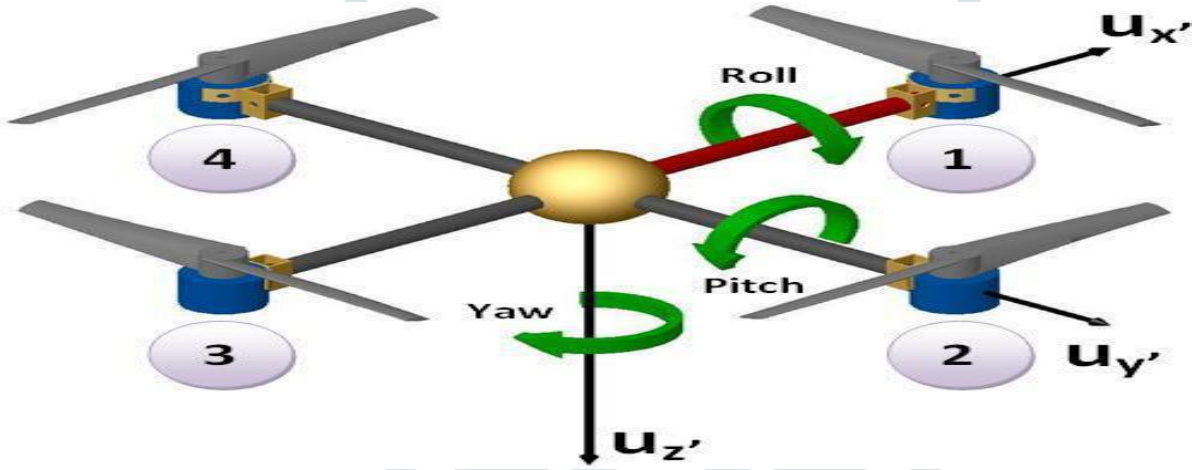


Figure 1: quad copter movements

## 3. Quad copter Design and Analysis

The main objective of this work is to create and design Quad copter delivery system:

1 Design of a quad copter

2 Modeling of a quad copter

3 Analysis of quad copter

### 3.1 Design of a quad copter

The following design is taken from the paper as a reference. Through this design the quad copter is modeled with the dimension given in the design. It includes design of a frame (F450) ,design of arms ,design of a motor

A. Frame Material

After comparison of various materials available for frame body, Glass Fibre Reinforced Plastic (GFRP) is selected due to its high tensile strength, easy availability; less density hence light weight and good damping property during vibrations.

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Frame design

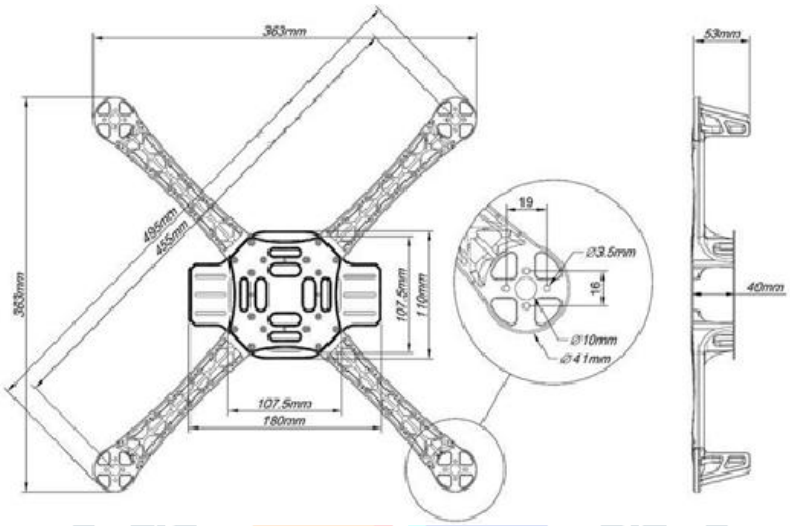


Figure 2: frame design

### 3.2 Modeling and control of a quad copter

The purpose of this paper is to present the basics of quad copter modeling and control as to form a basis for further research and development in the area. This is pursued with two aims. The first aim is to study the mathematical model of the quad copter dynamics. The second aim is to develop proper methods for stabilization and trajectory control of the quad copter. The challenge in controlling a quad copter is that the quad copter has six degrees of freedom but there are only four control inputs.For modeling of a Quad copter SOLIDWORKS software is being used.

Figure 3: Assembly of Model

### 3.3 Analysis of quad copter

In the ANSYS Workbench a CAD model is uploaded (cad model is modeled using SOLIDWORKS software) and the respective loads and forces are applied to check according to the type of analysis

Structural Analysis isperformed on the frame by using Glass fiber and carbon fiber material. The results of deformation and von mises stresses are compared and with the results the best suitable material is used for fabrication. The fixed support is added here and the analysis is performed on the frame and components of the Quad copter such as Arms and the base plate. The fixed support and the respective forces is added to perform analysis on the components and frame.

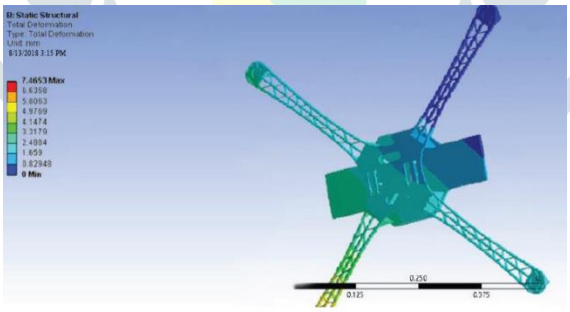

Figure 4: Total deformation of Frame

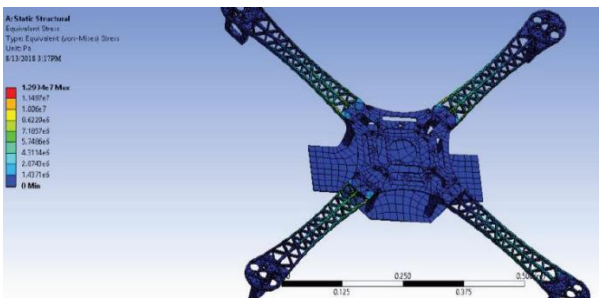

Figure 5: stresses on Frame

The analysis of the frame is performed and maximum and minimum deformation, stress values are obtained which is shown in the fig2 and fig 3. As we know the yield stress value of the glassfiber is 3445Mpa. The values obtained are within the stress limits so we can say that the frame can handle the applied load and it is within the safe limits

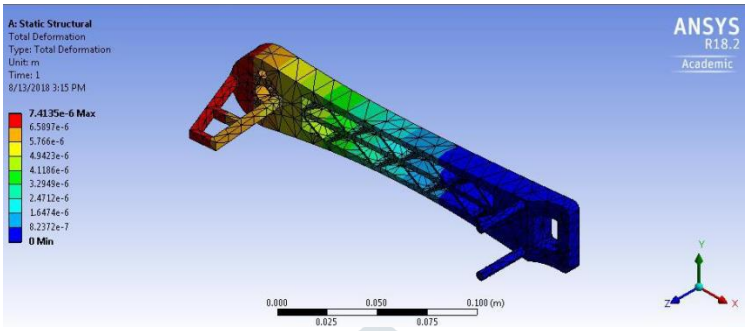


Figure 6: Max deformation of Arm

The front side of the ARM is taken as a fixed support as it is attached with lower and upper base plate then the force of 2.6975N (including motor weight and the frame weight) is added on the base of the arm and checked whether the material is capable of baring the amount of force applied. The results shown concludes that the maximum deformation is at 7.4135e-6 which shows the material is capable of baring the force applied.

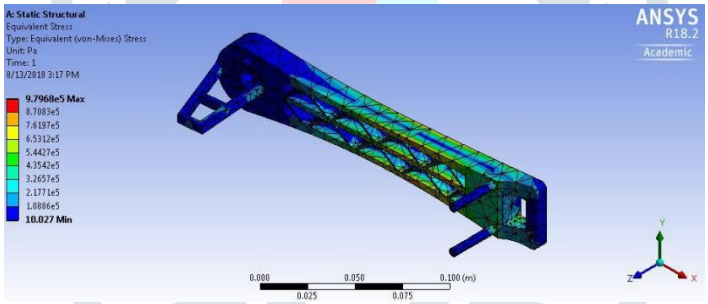


Figure 7: Deformation of Base Plate

### 3.4 Analysis on Frame for CARBON FIBER

Another material carbon fiber is selected, So as to compare the values of Total deformation and the Von mises stress obtained in frame analysis with glass fiber.

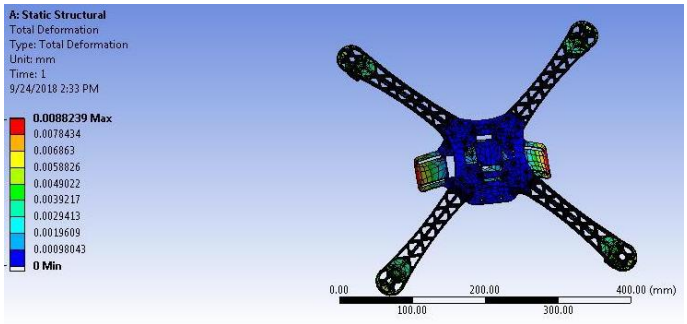


Figure 8: Total deformation in frame with carbon fiber

The same steps is being followed for analysis i.e. keeping the upper plate as fixed support and applying the forces on arms and base plate (motor and frame self-weight on the arms) , gripper, payload, battery etc

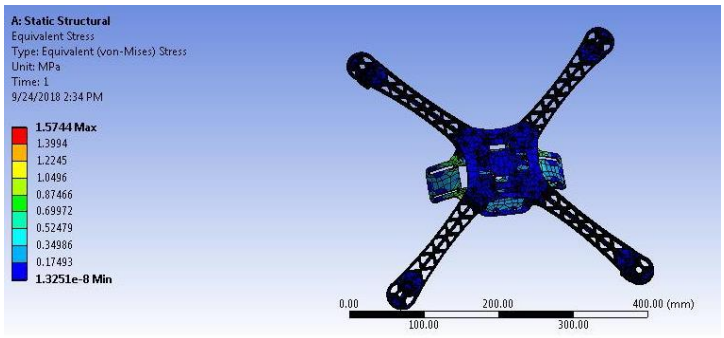


Figure 9: Von mises stress with carbon fiber

## 4. Analysis of a Gripper

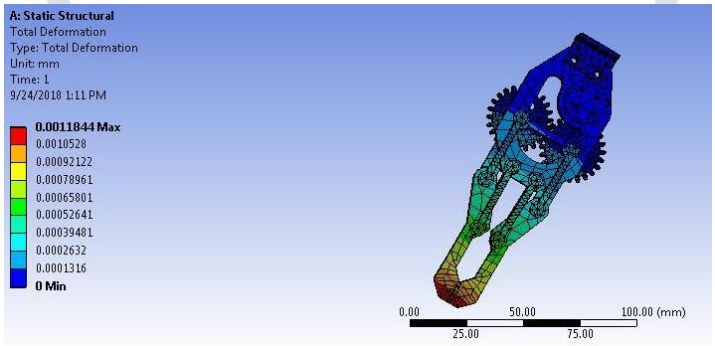


Figure 10: total deformation on gripper

For the analysis on gripper aluminum material is used and values of deformation and von mises stress is calculated .The results in deformation when the fixed support is applied on the top surface and the force from 100gms to 500gms is applied

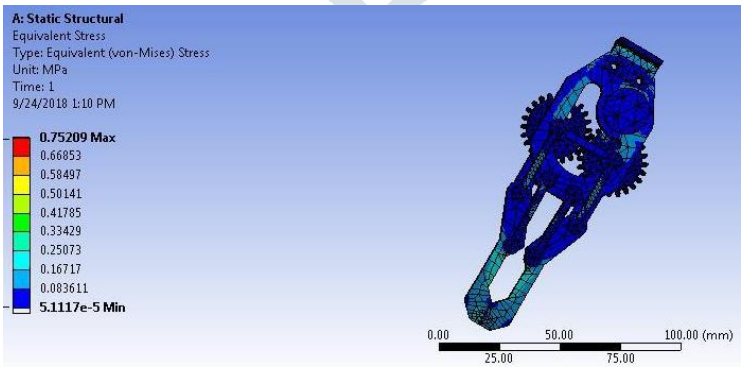


Figure 11: von mises stress on gripper

| Payload | Maximum Deformation values (in mm) | Maximum Von mises stress Values (in Mpa) |
|---|---|---|

| | | |
|---|---|---|
| 100gms | 0.000235 | 0.1504 |
| 200gms | 0.000471 | 0.3008 |
| 300gms | 0.000671 | 0.4512 |
| 400gms | 0.000942 | 0.6017 |
| 500gms | 0.00118 | 0.7520 |

Table:1 Various deformations and von mises stresses

The table:1 shows the various deformations and von mises stresses on the gripper with the different payloads from 100gms to 500gms.

## 5. RESULTS AND DISCUSSIONS

By studying the design of quad copter and its material for each part, final assembly of quad copter is prepared and CAD model analysis is carried out on quad copter frame. The modeling is done in solid works

Static structural analysis for Glass fiber, the results shows that the deformation in model is minimized to 0 m and maximum up to is 3.3887e-5 m. Von mises stress result is minimum 378.91 Pa and for the Carbon fiber the maximum Deformation value is 0.0088 mm. The occurred deformation is acceptable. Von mises stress result is maximum 1.5774 Mpa and that brings us to conclusion that the Glass fiber is suitable for the frame material as this weight of the quad copter is increased when carbon fiber is used which decreases the payload capacities this quad copter is capable of lifting the given payload and the weight lying is under the stress limits.

## 6. CONCLUSIONS

The modeling and fabrication of pick and place quad copter is done .The modeling of parts like frame , motor,blade,gripper is carried on the SOLIDWORKS(2015) software. The assembly is done with no interferences and the aim of the optimal weight of the quad copter is achieved .The entire weight of the quad copter is around1320gms.By applying the amount of thrust required during different maneuvers of quad copter, gravitational force, self-weight of components attached to frame, deformation, stress, is studied using Ansys 15.0. As Frame is the important part so the static structural analysis is done on the frame by applying fixed supports and the respective forces on the arms and the base plates (which includes motor weight and the other component weights like battery, gripper, payload etc) using both Glass fiber and carbon fiber material so as to know the values of deformation and von mises stresses .The results of both the materials are compared and the best material is selected

The maximum deformation value for glass fiber is 7.456mm and maximum stress is $1.2904e^{-5}$mpa and the maximum deformation value for carbon fiber is 0.0088mm and maximum stress value is 1.5744mpa. Because of non-availability of carbon fiber, glass fiber is used.Deformation and stress results for different types of analysis are within limit. So it is concluded that the design for quad copter is safe. Also the structural analysis on gripper is done by applying payloads from 100gms to 500gms

which gives the different values of deformation and von mises stress according to the payload applied. By comparing the values of both materials glass fiber and carbon fiber we can conclude that Glass fiber can be used as the frame material which is reliable for quad copter and the quad copter can resist the payload applied. Quad copter is becoming prevalent worldwide. Various researches on this device were performed to make it efficient and effective.

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