

# **Design and Fabrication of Multipurpose Agricultural Drone Frame**

Submitted in partial fulfilment of the requirements for the award of

Bachelor of Engineering degree in

Aeronautical Engineering

By

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**DEPARTMENT OF AERONAUTICAL ENGINEERING**

**SCHOOL OF MECHANICAL ENGINEERING**

**SATHYABAMA**

**INSTITUTE OF SCIENCE AND TECHNOLOGY**

**(DEEMED TO BE UNIVERSITY)**

**Accredited with grade “A” by NAAC**

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**MARCH 2021**



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**DEPARTMENT OF AERONAUTICAL ENGINEERING**

**BONAFIDE CERTIFICATE**

This is to certify that this Project Report is the bonafide work of **Vijay Kumar Pepakayala (Reg. No. 37260049)** and **Jay Manoj Kinnake (Reg. No. 37260018)** who carried out the project entitled "**Design and Fabrication of Multipurpose Agricultural Drone Frame**" under our supervision from September 2020 to March 2021.

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**Dr. Anderson., M.E., Ph.D.,**

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**Submitted for Viva voce Examination held on \_\_\_\_\_**

**Internal Examiner**

**External Examiner**

## **DECLARATION**

I **Vijay Kumar Pepakayala (Reg. No. 37260049)** hereby declare that the Project Report entitled “**Design and Fabrication of Multipurpose Agricultural Drone Frame**” done by me under the guidance of **Dr. Anderson, M.E., Ph.D.**, is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering degree in Aeronautical Engineering.

**DATE: 17.04.2021**  
**OF THE CANDIDATE**

**SIGNATURE**

**PLACE: CHENNAI**

## ACKNOWLEDGEMENT

I am pleased to acknowledge my sincere thanks to Board of Management of **SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. I am grateful to them.

I convey my sincere thanks to **Dr. S. Prakash, M.E., Ph.D.**, Dean, School of Mechanical Engineering and **Dr. P. Booma Devi M.E., Ph.D.**, Head of the Department, Dept. of Aeronautical Engineering for providing me necessary support and details at the right time during the progressive reviews.

I would like to express my sincere and deep sense of gratitude to my Project Guide **Dr. Anderson M.E., Ph.D.**, for his valuable guidance, suggestions and constant encouragement paved way for the successful completion of my project work.

I also express my thanks to all Teaching and Non-teaching staff members of the Department of Mechanical Engineering who were helpful in many ways for the completion of the project.

## ABSTRACT

UAV (Unmanned Aerial Vehicle) are Robots that are equipped for flying without installed pilot. It is an advancing new innovation for agricultural nations like India and could be sent for ecological exploration applications like aerial observation, assessment, conveyance of medication, preservation reconnaissance, seed planting, reforestation and some more. It very well may be controlled both physically and self-rulingly. The use of huge helicopters and other flying can be substituted for certain applications by UAV's making those applications modest and dependable. This would be profoundly beneficial when being worried about the expense and danger of activity of the airborne vehicles. For purposes like calamity the executives, conveying clinical guides and extraordinary salvage activities, UAVs could substantiate themselves far commendable and practical. There are different sorts and plans (Multirotor and fixed wings) of UAVs accessible in the worldwide market however not effectively accessible with regards to India. The UAV we planned and created is called SIST-COP, which is a multirotor with six rotors (actually called as hexacopter). It can vertically take off and land with the reason to take aeronautical reconnaissance and supply clinical guides and furthermore shower compost or a sanitizer. Since the extent of Unmanned Airborne Vehicle (UAV) is wide, its advancement will clear a way for the college in investigating different applications with regards to non-industrial nations like India. Its native plan and advancement give the change premise to further and includes expansion as indicated by the territory of use like reforestation, line of control security, war toll, firefighting, and so on The SIST-COP isn't just a physically guided vehicle yet additionally it has got its own cerebrum to take choices in crucial conditions such as hindrances or failing to catch plane ways and so forth our primary focus is to fabricate the edge of SIST-COP as it extremely hard to get or import any substantial payload drone outline in India because of some lawful limitations on drones. SIST-COP is a canny and complete drone to all the accessible market drones and without a doubt it will be a progressive casing in Indian market in the forthcoming years.

**Keywords:** Unmanned Aerial Vehicle, Observation, Conveyance, Medicine delivery, Worldwide market, SIST-COP, non-industrial nations, reforestation, cerebrum (brain).

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## **LIST OF SYMBOLS AND ABBEREVIATIONS**

|              |                                     |
|--------------|-------------------------------------|
| <b>AUW</b>   | ALL UP WEIGHT                       |
| <b>AWG</b>   | AMERICAN WIRE GAUGE                 |
| <b>ACAS</b>  | AIRBORNE COLLISION AVOIDANCE SYSTEM |
| <b>BEC</b>   | BATTERY ELIMINATOR CIRCUIT          |
| <b>BLDC</b>  | CRUSHLESS DC MOTOR                  |
| <b>ESC</b>   | ELECTRONIC SPEED CONTROLLER         |
| <b>FPV</b>   | FIRST PERSON VIEW                   |
| <b>FC</b>    | FLIGHT CONTROLLER                   |
| <b>GPS</b>   | GLOBAL POSITIONING SYSTEM           |
| <b>IMU</b>   | INERTIAL MEASUREMENT UNIT           |
| <b>KV</b>    | KILO VOLT                           |
| <b>LOS</b>   | LINE OF SIGHT                       |
| <b>MAH</b>   | MILLI AMP HOUR                      |
| <b>PDB</b>   | POWER DISTRIBUTION BOARD            |
| <b>RX</b>    | RECIEVER                            |
| <b>RTH</b>   | RETURN TO HOME                      |
| <b>RTL</b>   | RETURN TO LAND                      |
| <b>TOW</b>   | TAKE OFF WEIGHT                     |
| <b>TX</b>    | TRANSMITTER                         |
| <b>XT-90</b> | POPULAR BATTERY CONNECTOR           |

## **CHAPTER 1**

### **1 INTRODUCTION**

The advantage of mission possibilities of UAV in various sectors its demand has been increasing as days pass. This led to commercial evolution of parts and components of UAS in developed countries. Meanwhile for upcoming countries, the idea of UAVs is still in evolving phase. So, the development and commercial production of UAV and all of its components has not yet been widely deployed. This is the reason that our focus for the design and development of hexa-copter has been constrained to the design of the frame and selection of appropriate and economic material for the manufacture of the frame. By attaching the readily available electronic components, available in the market at affordable price, on the frame designed and developed by us, we are successful in making a fully functioning hexa-copter.

#### **UAV's (UNMANNED AERIAL VEHICLE's)**

Unmanned aerial vehicles are the robots that fly without any person on it with the help of on-board sensors and controlled by the commands from the ground person. These are known as drones. Drones are flexible of flying anywhere in this world. They can penetrate in to small drainages to collapsed buildings, they can act as a fire fighter as well as a victim rescuer during disasters. They can plant a whole forest within days they can water hectares of land within minutes. The application of drones is evolving each and every day. Drones are the most capable robots to capture the birds eye view. Almost every sector in the market needs a drone to be with them. As an example, we can take hospitals to deliver first aid kits, hotels to deliver food, military to monitor borders, photographers to capture aerial images and to take fantastic shots. and the list goes on

UAVs are of different types, sizes and shapes, lets discuss few types below.

### 1.1 Classification by size:

For characterization as indicated by size, we can mark into the underneath sub-classes:

- minuscule UAVs

O Micro or Nano UAVs

- Small UAVs

O Mini UAVs

- Medium UAVs

- Large UAVs

UAVs likewise can be arranged by the reaches they fly and their perseverance utilizing the accompanying sub-classes created by the DGCA:

- low-cost short proximity UAVs
- Close-range UAVs
- Short-range UAVs
- Mid-range UAVs
- Endurance UAVs

**Table 1. Categories**

| Category    | Altitude (ft) | Endurance (hr) | Range (km) | Weight (kg) |
|-------------|---------------|----------------|------------|-------------|
| Micro       | <300          | 1              | <5         | <1          |
| Mini        | <10,000       | 1-6            | <25        | <25         |
| Close Range | <15,000       | 4-8            | <75        | <200        |
| Small Range | <25,000       | 8-24           | <200       | <750        |
| Medium      | <30,000       | >24            | >1,000     | >1000       |
| Large       | <40,000       | >24            | >1,000     | >2000       |
| Hale        | >45,000       | >24            | >1,000     | >3000       |

## **1.2 Classification by type:**

"Drones" can be one-sided on usage like Drones for Photography, Drones for airborne Planning, Drones for Reconnaissance and so forth In any case, the best variety of 'Drones' should be possible based on aeronautical areas. In view of the kind of stage utilized, there are 4 significant sorts of robots.

1. Multi Rotor Robots
2. Fixed Wing Robots
3. Single Rotor Helicopter
4. Fixed Wing Mixture VT

### **1.2.1 Multi Rotor Drones**

These are the most well-known classification of robots which are utilized by Businesses and people the same. They are utilized for ordinary applications like flying photography, airborne video observation and so forth Different kinds of items are accessible in this area on the lookout. multi-rotor drones for picture takers utilizes like airborne photography (costs fluctuate from 1lakh to 5lakh rupees) and there are heaps of variations for interest purposes like novice drone dashing, or relaxation flying (cost shift from 35000 to 200000 rupees). Multi rotor drones are the least demanding to make and the most effortless to fly when contrasted with the excess area drones.

Multi-rotor robots can likewise be grouped dependent on the quantity of rotors on the stage. They are Tricopter (3 rotors), Quadrotor (4 rotors), Hex rotor (6 rotors) and Octocopter (8 rotors). Out of these, Quadrotors are the most renowned and limitlessly utilized variation. In spite of the fact that it is easy to fabricate and similarly modest, multi-rotor drones have numerous disadvantages. They have restricted flying time, restricted perseverance and speed. They are not able for enormous scope items like

long reach airborne planning or reconnaissance. The numerical issue with the multi rotor is they need to spend a lot of their energy (from a battery source) just to battle gravity and settle themselves noticeable all around. right now, a large portion of the multi-rotor drones out in the market are able to do simply a 20 to 30 minutes flying time (regularly with an insignificant payload like a camera).



*FIG 1.2.1 Multi Rotor*

### **1.2.2 Fixed Wing Drones**

Fixed Wing drones are completely different in design and build to Quad or Hex Rotor type design. They use a 'wing' like the normal aero planes in the market or the real ones. These are not similar to Quad or Hex rotor drones, fixed-wing type models won't consume energy to stay in a single position on-air (fixed-wing types can't hover in the air at one place) fighting gravity. Rather, they just move along the planned path set by the user until they have energy to fly.

Most fixed-wing drones have a mean flying time of a few hours. Gas powered planes can fly more than 15 hours . due to their higher-flying time and greater fuel efficiency, fixed-wing drones are ideal for long-distance operations (be it mapping or surveillance). But they cannot be used for aerial photography as they need to stand still in the air for a longer time and that can be done only with the help of a multirotor.

It's difficult to keep a strong and fast wing drone within the air. A catapult or a runway is needed to launch the drone into air and make it align with the flight path . A runway or a parachute or a net is mandatory to land them back in the ground safely. comparatively multirotor are safe and cheaper than these planes, someone who has good money can buy a quadcopter equipped with a GPS. Flying a quadcopter doesn't require special training. You just take them to an open area and fly them. Guiding and controlling a quadcopter are often learned on the go.



***Fig 1.2.2 Delta Wing***

### 1.2.3 Single Rotor Drones

Single rotor drones are comparative in each viewpoint to genuine helicopters. In contrast to a typical robot, one engine model has just one major estimated engine in addition to a little one on the tail of the robot to control its heading. Single rotor drones are a lot of proficient than quad or hex rotor variants. They have higher flying occasions and may even be fueled by gas motors. In streamlined features, the lower the tally of rotors the lesser will be the twist of the thing. Also, that is the huge motivation behind why quadcopters are more steady than octocopters. with respects, single rotor drones are a lot of effective than Quad or Hexa or Octa drones.

Nonetheless, these machines contain a lot higher complexations and operational dangers. Their expenses are likewise on the higher side. The hefty estimated rotor edges regularly have a danger (lethal mishaps are recorded from rc copter mishaps) if the robot is misused or includes in a mishap. Multi-rotor drones, regularly because of their little rotor edges haven't been engaged with lethal mishaps (however a scar on the actual body is likely). They likewise request uncommon preparing to fly them on air appropriately (however they'll not need haven't been involved in fatal accidents (though a scar on the physical on air).



***Fig 1.2.3 RC Helicopter***

### 1.2.4 Hybrid VTOL

VTOLs are the advanced versions combining the advantages of Fixed-wing models (higher flying time) with that of quad or hexacopter or fixed-wing based models (hover). This concept has been tested since around 1960's without much success. However, with the arrival of the latest generation sensors (gyros and accelerometers), this idea possesses some new life and direction.

FIG 1.2.4



## CHAPTER 2

### 2 LITERATURE SURVEY

#### **2.1 DESIGN, FABRICATION, AND SIMULATION OF HEXACOPTER (2018)**

**Author: Vijayanandh Raja, M. Dinesh (Kumaraguru College of Technology):**

Unmanned Aerial Vehicles (UAV) is being suggested for essential applications like limit perception, problematic arranging and climate consider. Especially in military application, it puts to the side money and lives of officials diverged from the mama observed military aero plane Serious issues inside the woods line locale are human-creature collaboration and creatures poaching. With the help of the whole reconnaissance, these issues can prepare to tackle. These days the reconnaissance round the woodland has been regulated by timberland officials. Checking the woodland through officials isn't finished observation, because of the common elements of the populace could likewise be the blunder will happen inside the checking. To stay away from this issue, the seeing of the backwoods district is to be covered by UAV. Creature exercises and colossal backwoods inclusion territory is a troublesome undertaking to deal with in woods observing, so a conventional UAV isn't reasonable for this interaction, subsequently Hexacopter might be a superior response for this checking in light of the fact that it's a have special characters like high operational speed, greater steadiness, and so on The proposed Hexacopter would be fit for the vertical take-off and landing highlight kind of a rotor edge airplane and furthermore the six propellers give greater strength and high moving capacity during the checking cycle. This Hexacopter payload is about 1kg and the complete measurement is 500mm x 500mm, the preeminent motivation behind this hexacopter is to give rich reconnaissance inside the woodland and gives alert about the creature's unmistakable position and makes an important move. The surveyed plan of hexacopter has been shown by CATIA. With the help of MATLAB 10.0 the picture preparing has been directed in order to search out creature discovery, creature chasing and creature The crisis framework will be instituted in the record of slip-up creature coordinating with rate yield from picture handling.

the proposed Hexacopter might be a superior answer for creature poaching, creature human collaboration issue and creature tallying's and furthermore it's one-of-a-kind characters like simpler flight, less vibration so it can prepared to solid and able to

look up to any basic climate for an application like creature recognition, enactment of the notice framework. With the help of six propellers hexacopter can prepared to follow any moving creature additionally

as cover the whole predefined woods locale. Picture preparing has been done in various cases by MATLAB for ready enactment reason. The Distant Controlled hexacopter model has been managed and subsequently the picture handling results are plotted. The completely independent hexacopter and its continuous recreation results will be directed .and its ongoing reproduction results will be regulated.

## **2.2 AUTONOMOUS HEXACOPTER SOFTWARE DESIGN (2014)**

**Author: Michael Baxter (University of Western Australia)**

automated flying vehicles are a popular exceptional stage for self-sufficient mechanical technology research. This report diagrams the plan and execution of multithreaded programming for a hexacopter constrained by a raspberry pi. A variety of sensors including a GPS, an IMU and a camera are utilized on the hexacopter, and consequently the product is obligated for gathering information from and checking these sensors through their lower-level libraries. A specific methodology is taken to programming plan so the framework can be utilized in an assortment of utilizations. The applications had a go at during this undertaking were: GPS waypoint route and single shaded article following. GPS course was refined with the best path deviation of 5.66m. A conversation on enhancements to the route calculation and thusly the fuse truth be told rectification strategies is given. object following figuring's were completed utilizing the focal point of mass and camshaft techniques, which were overhauled using HSV thresholding, query tables and decreased shading spaces. The hexacopter was prepared to follow a red article moving at a lethargic waking speed for a full preliminary, 1.13 minutes long. The product introduced is adaptable, presently being used with other synchronous undertakings and sets out a structure for future turn of events. A multithreaded programming framework was intended for and carried out on an independent hexacopter. The measured plan made this strategy adaptable and versatile. The utilization of murex's to ensure assets across strings makes the plan strong. The product framework was demonstrated to effectively control a hexacopter in independent flight. GPS waypoint route was accomplished with a way deviation equivalent to a year ago. Camera

picture preparing smoothed out, viably multiplying past outline rates. At last, the article following was supported for 1.13 minutes, the whole length of the test. This framework is presently being used with a spread of synchronous ventures, including field looking and various item following, all tied in close by a web-based interface

### **2.3 ADAPTIVE NEURAL ALTITUDE CONTROL AND ATTITUDE STABILIZATION OF A HEXACOPTER WITH UNCERTAIN DYNAMICS (2019)**

**Author: Ahmad Jobran Al-Mahasneh; Sreenatha G Anavatti**

Robotized Flying Vehicles (UAVs) are as of late pulling in critical examination consideration because of their possible applications in numerous fields. Hexacopter UAV offers higher payloads taking care of and flaws resistance than a quadcopter yet its control could likewise be a requesting task. during this paper, a flexible Neural Organizations (NN) controller is proposed for tallness following and stature adjustment of a hexacopter UAV with dubious elements. The regulator plan, reenactment and life against impact unsettling influences are examined. Likewise, the regulator execution is contrasted and a run of the mill Separated Corresponding Subsidiary Integrator (FPID) regulator for different control situations.

### **2.4 REVIEW OF HEXACOPTER DRONE (2018) Author: B M Alba kier, Alaa H. Muttar, Ali J. Askir (Al-Iraqia University, Iraq)**

Numerous endeavors and work were at that point accomplished and accessible in the writing. The past accessible endeavors can be summed up as in the accompanying subsections. Helicopter Adding payload mass to a helicopter changes the unique reaction of the framework. The airplane's flight control framework should keep on keeping up strength with adjusted demeanor elements and should likewise dismiss any inclination force initiated by a moved focus of mass. On the off chance that the regulator doesn't keep up steadiness with changed mass boundaries, or can't dismiss the progression aggravations because of added force inclination from uneven stacking, the framework will be destabilized at whatever point an item is gotten a handle on. This is particularly significant where a direct business off the half framework is utilized, which may not be versatile to a changing plant mid-flight. joining mass to the vehicle reduces the common recurrence of the disposition elements this has the benefit of sifting through high-recurrence unsettling influences

yet makes it harder to influence quick course corrections. While numerous programmed copters have flown with fastened burdens, the throw setup is explicitly intended to decouple the movement of the heap from the helicopter and separate the timescales of the demeanor and tie pendulum elements. On account of got a handle on and unbendingly appended loads, the payload is straightforwardly coupled to vehicle pitch and horizontal movements the shut circle framework should be appeared to stay stable inside the normal scope of framework mass and latency.

This work includes the occasion and joining of hexacopter utilizing an APM microcontroller to manage the whole UAV developments. It likewise includes the blending and utilization of a UAV's camera to naturally build a region map upheld by the photos gained from the UAV while flying through a devoted region of interest. The outcomes show an effective control for a hexacopter to fly utilizing a ground pilot with RC control.

## **2.5 DESIGN OF FUZZY CONTROLLER FOR HEXACOPTER POSITION CONTROL.**

**Author: Jan Bacik, Palov Fedor (Technical University of Kosice, Kosice, Slovakia) (2017)**

This paper enlightens us concerning the arranging of a fluffy regulator for controlling the situation of a hexacopter appeared by a recreation model in the Gazebo robot reproduction climate, which as far as control gives a high framework 6 levels of opportunity. The fluffy regulator configuration was upheld the pilot's insight and on investigation of exploratory information gathered during a controlled hexacopter flight, without the information on its design and boundaries. The fluffy regulator properties were affirmed by continuous test esteems, with an examining season of 10 milliseconds. The outcomes have shown great unique properties of the PI fluffy regulator, which may in future be additionally applied during a genuine physical hexacopter model.

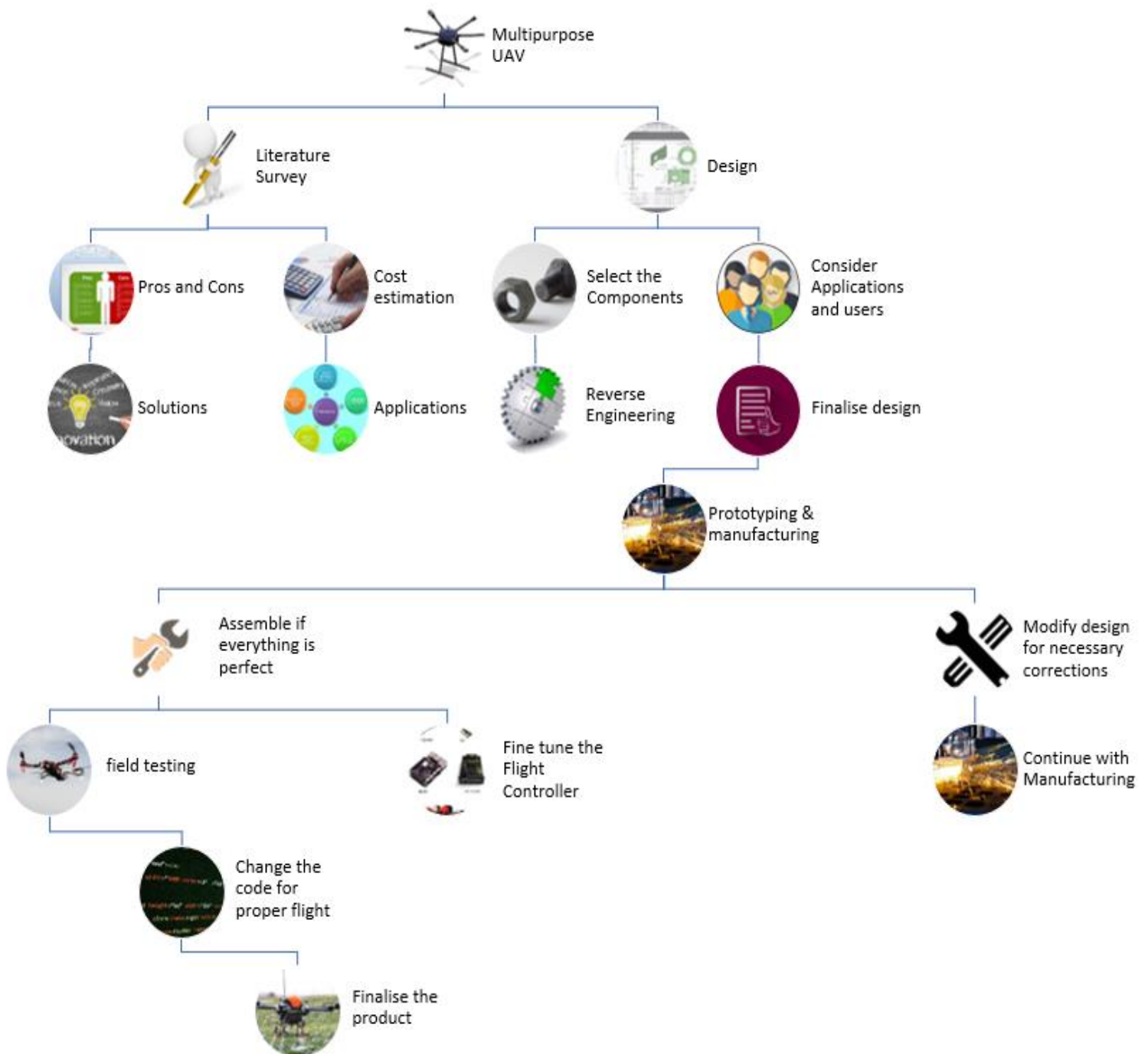
## **CHAPTER 3**

### **3.1 AIM AND SCOPE OF THIS PROJECT**

**Aim:** To Make a Hexa-Copter Frame that withstands a load of 90kgs and serves for multipurpose with unique features when compared to any other frame in Indian market.

Because of the immense region of mission prospects of UAV in different areas its interest has been expanding step by step. This has prompted the business improvement of parts and segments of UAV in created nations. Then, for non-industrial nations, the idea of UAV is as yet in an advancing stage. So the turn of events and business creation of UAV and the entirety of its parts has not yet been generally drilled. That is the motivation behind why our concentration for the plan and improvement of hexacopter has been restricted to the plan of the casing and choice of fitting and monetary material for the production of the casing and furthermore making it simple to versatile and less weight. By collecting the instant electronic segments, accessible in the market at a moderate cost, on the edge planned and created by us, we have had the option to build up a completely working hexacopter. Which effectively sprays, conveyance, planting, examination, catastrophe the board, flying shooting and photography and so on.

### 3.2 Methodology Chart



## CHAPTER 4

### 4.1.MATERIALS USED

#### 4.1.1 MDF

Medium-thickness fibreboard is a designed wood item made by separating hardwood or softwood residuals into wood strands, regularly during a defibrillator, consolidating it with wax and a pitch fastener, and framing it into boards by applying warmth and pressing factor. MDF is for the most part denser than compressed wood...



**FIG 4.1 MDF SHEETS**

#### 4.1.2 ACRYLIC

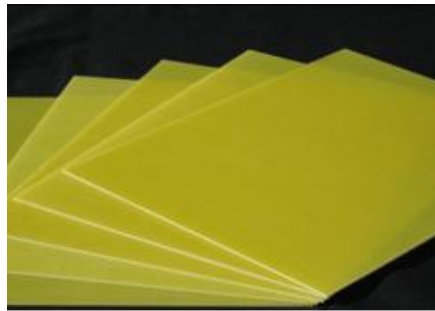
Poly(methyl methacrylate), additionally alluded to as acrylic, acrylic glass, or plexiglass, likewise as by the trademarks Crylux, Plexiglas, Acrylite, Astariglas, Lucite, Perclax, and Perspex, among a few others, is a straightforward thermoplastic regularly used in sheet structure as a light-weight or break safe choice to glass.



**FIG 4.2 ACRYLIC SHEETS**

#### **4.1.3 GLASS FIBRE**

Glass fiber (or glass fiber) might be a material comprising of different amazingly fine strands of glass. Glass makers all-around history have explored different avenues regarding glass filaments, yet mass production of optical fiber was just made conceivable with the development of better machine tooling.



**FIG 4.3 GLASS FIBRE**

#### **4.1.4 CARBON FIBRE**

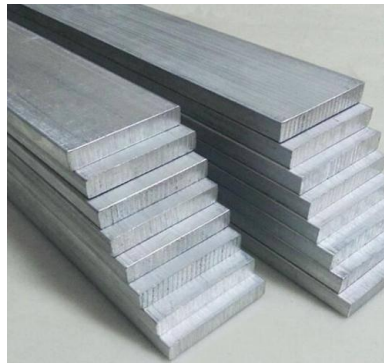
Carbon filaments or carbon strands are 5 to 10 micrometers in breadth and made generally out of carbon iotas. Carbon filaments have a few benefits including high solidness, high lastingness, low weight, high substance obstruction, heat resistance and low warm development. Carbon filaments or carbon strands are 5 to 10 micrometers in breadth and made generally out of carbon iotas. Carbon filaments have a few benefits including high solidness, high lastingness, low weight, high substance obstruction, heat resistance and low warm development.



**FIG 4.4 Carbon Fibre**

#### **4.1.5 ALUMINIUM**

Aluminum might be a component with the image Al and number 13. Aluminum includes a thickness not exactly those of other normal metals, at around 33% that of steel. It has superb insurance against oxygen and structures a defensive layer of oxide on a superficial level when presented to air...Aluminum might be a component with the image Al and number 13. Aluminum includes a thickness not exactly those of other normal metals, at around 33% that of steel. It has superb insurance against oxygen and structures a defensive layer of oxide on a superficial level when presented to air...



**FIG 4.5 Aluminum Sheets**

**TABLE 2. Material Properties Comparison sheet**

| Material     | Elastic modulus<br>10 <sup>6</sup> psi | Shear modulus<br>10 <sup>6</sup> psi | Yield strength<br>10 <sup>6</sup> psi | Tensile strength<br>10 <sup>6</sup> psi |
|--------------|----------------------------------------|--------------------------------------|---------------------------------------|-----------------------------------------|
| Aluminum     | 70                                     | 3.5                                  | 350                                   | 110                                     |
| Carbon fiber | 150                                    | 30                                   | 611                                   | 3190                                    |
| Acrylic      | 4                                      | 1                                    | 70                                    | 225                                     |
| Glass Fibre  | 17                                     | 24                                   | 450                                   | 2000                                    |
| MDF          | 3.2                                    | 0.17                                 | 137                                   | 174                                     |

|                 | Matrix                                              | Fibre                                                         |
|-----------------|-----------------------------------------------------|---------------------------------------------------------------|
| Elastic Modulus | $E_m := 3.6 \cdot \text{GPa}$                       | $E_f := 224 \cdot \text{GPa}$ $E_{ft} := 14 \cdot \text{GPa}$ |
| Density         | $\rho_m := 1.3 \cdot \frac{\text{gm}}{\text{cm}^3}$ | $\rho_f := 1.81 \cdot \frac{\text{gm}}{\text{cm}^3}$          |
| Poissons ratio  | $\nu_m := 0.37$                                     | $\nu_f := 0.2$                                                |
| Shear Modulus   | $G_m := G(E_m, \nu_m)$                              | $G_f := 14 \cdot \text{GPa}$                                  |

## 4.2 Manufacturing Methods Used

### 4.2.1 Laser cutting

Laser cutting is a very good quality innovation that utilizes a laser to cut parts or sheets. Laser cutting guides in mechanical assembling applications, at the outset, it is utilized by schools, independent ventures, and specialists. Laser cutting works by coordinating the yield of a powerful laser most normally through optics. The laser optics and CNC (PC mathematical control) don't immediate the texture or the shaft created. A business laser for cutting materials utilizes a movement framework to follow a CNC or G-code of the example to be cut onto the texture. The engaged shaft is aimed at the texture, which at that point either softens, consumes disintegrate away, or is overwhelmed by a fly of gas,[1] leaving a traction with an excellent surface completion. Laser cutting is a very good quality innovation that utilizes a laser to cut parts or sheets. Laser cutting guides in mechanical assembling applications, at the outset, it is utilized by schools, independent ventures, and specialists. Laser cutting works by coordinating the yield of a powerful laser most normally through optics. The laser optics and CNC (PC mathematical control) don't immediate the texture or the shaft created. A business laser for cutting materials utilizes a movement framework to follow a CNC or G-code of the example to be cut onto the texture. The engaged shaft is aimed at the texture, which at that point either softens, consumes disintegrate away, or is overwhelmed by a fly of gas,[1] leaving a traction with an excellent surface completion.



**FIG 4.2.1 laser cut MDF board**

#### **4.2.2 CNC cutting**

A PC mathematical control (CNC) switch is a PC controlled cutting machine that regularly holds a hand-held switch as a shaft that is utilized for cutting different materials, similar to wood, composites, aluminum, steel, plastics, glass, and froths. CNC switches can do the assignments of the numerous carpentry shop hardware like the board saw, the shaft disintegrate, and along these lines the exhausting machine. they will likewise cut joineries like mortises and joins. A CNC router is extremely similar in concept to a CNC miller. rather than routing by hand, tool paths are controlled via computer numerical control. A PC mathematical control (CNC) switch is a PC controlled cutting machine that regularly holds a hand-held switch as a shaft that is utilized for cutting different materials, similar to wood, composites, aluminum, steel, plastics, glass, and froths. CNC switches can do the assignments of the numerous carpentry shop hardware like the board saw, the shaft disintegrate, and along these lines the exhausting machine. they will likewise cut joineries like mortises and joins.

A CNC router is extremely similar in concept to a CNC miller. rather than routing by hand, tool paths are controlled via computer numerical control. The CNC router is one among many sorts of tools that have CNC variants.



**FIG 4.2.2 CNC ROUTER**

### **4.2.3 3D printing**

The creation of a three-dimensional structure from a CAD model or a digital 3D model is known as 3D printing or additive manufacturing. The term "3D printing" can refer to a range of processes in which material is deposited, joined, or solidified under machine control to create a three-dimensional structure, with the material being added together (for example, plastics, liquids, or powder grains being fusible).

In the 1980s, 3D printing methods were assumed to be only useful for the assembly of practical or decorative prototypes, and rapid prototyping was a more fitting concept. As of 2019, 3D printing's accuracy, repeatability, and material selection have improved to the point that certain 3D printing processes are now deemed feasible as an industrial-production technique. whereby the term additive manufacturing is often used synonymously with 3D printing. One of the key advantages of 3D printing is that the ability to supply very complex shapes or geometries that might be otherwise impossible to construct by hand, including hollow parts or parts with internal truss structures to scale back weight. Fused deposition modelling, or FDM, is that the commonest 3D printing in use as of 2020. 3D printing, or additive manufacturing, is that the construction of a three-dimensional object from a CAD model or a digital 3D model.

**FIG 4.2.3 Ender 3 3D Printer**



### **4.3 INITIAL DESIGN PROCESS**

Sprayer drones are latest contraptions open to farmers to apply pesticides to little land locales and acreages. These robots can show up at the land that is exorbitantly wet or regardless inaccessible by individuals and may give more noticeable shower intrusion into the plant overhang. Moreover, people can stay far away from sprinkling exercises, which helps with lessening compound polluting to living animals.

In this way, we began with a fundamental plan, the plan went from papers to board and afterward to a product and the reproduction programming and afterward on to a CNC machine lastly into our hands. While planning we thought about every one of the prerequisites of a client and did the plan definitely with insignificant blunders to give an expert look and ease of use.

I utilized Fusion 360 to 3D model and Autodesk CFD to reproduce the model, first and foremost, we have a few issues like less arm breadth, the engine mount isn't fitting, a shade can't go with all the hardware. And so, on yet sooner we thought of an ideal model that fills every one of the needs and furthermore does effective in each work. We likewise guaranteed that the robot is foldable for simple conveying reason and effectively separable landing stuff and battery mounts. Since horticulture is anything but a 365-day business we considered making our edge serve for numerous applications for instance envision an agribusiness drone getting changed over into a payload robot and afterward a camera drone inside the space of seconds trading of batteries takes at any rate 5-10 mins however with our extraordinary component battery plate can be eliminated and appended in a matter of few moments. The progress of our designs can be seen in the figures 4.3.1 to 4.3.4.

**FIG 4.3.1 failure design one**



**FIG 4.3.2 failure design two**



**FIG 4.3.3 failure design three**



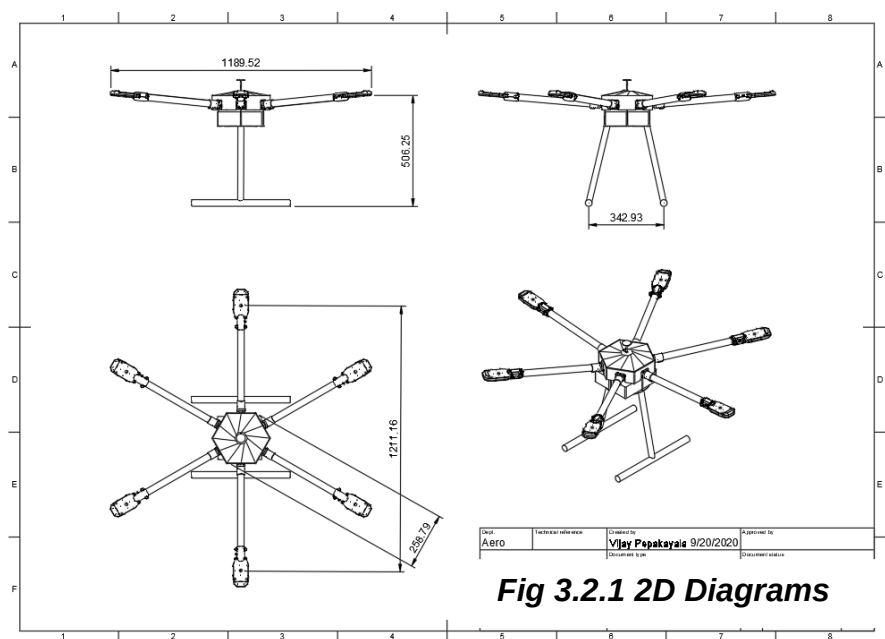
**FIG 4.3.4 failure design**



All these designs are practically not possible for my application  
As they are limited structurally limited as u can see  
Fig.1.1 has no stronger joints  
Fig.1.2 has very thin rods  
Fig.1.3 has small centre plate  
Fig.1.4 has smaller motor mounts

## 4.4 MAINFRAME DESIGN

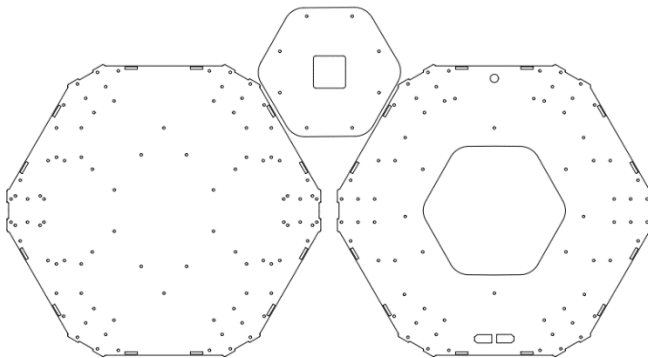
### 2D DESIGN OF FRAME AND PARTS



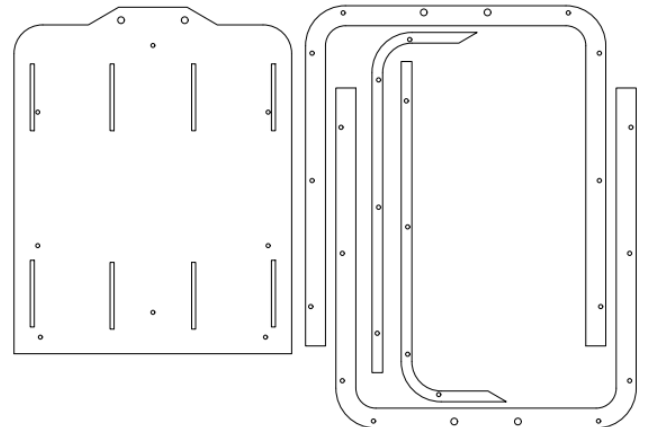
**Fig 3.2.1 2D Diagrams**

**Fig 4.4.1. FULL FRAME ASSEMBLY**

**Fig 4.4.2 TOP AND BOTTOM PLATES**



**Fig 4.4.3 BATTERY TRAY**



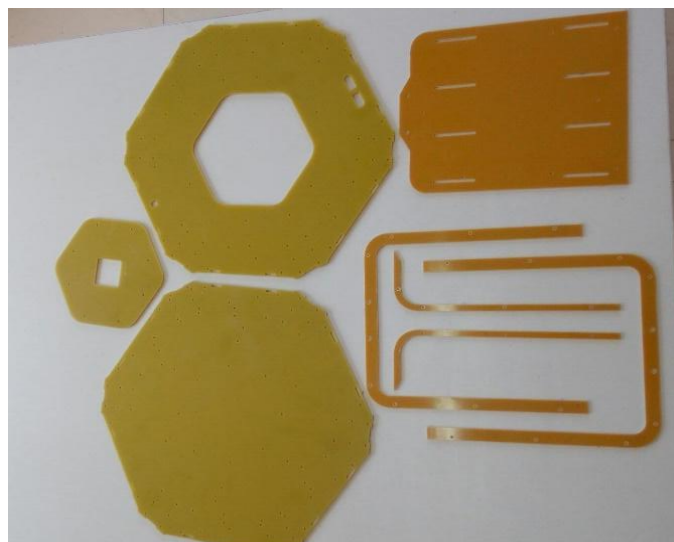
The mainframe design fig 4.3.1 is made for holding 6 arms and also it has all the mounting holes necessary to keep the electronics in place. The PDB and the FC goes at the center and the RX, telemetry and any other extra equipment will go to the sides of FC and PDB. The mainframe had a cut at the center of the top plat to access all the wires inside. i.e., connecting to the Pixhawk and PDB. The mainframe top plate has mounting holes for the battery tray and the GPS

At the beginning we have used MDF board to make a prototype using laser cut. Once we got a confirmation that the frame was of enough size, we proceeded with acrylic sheets to check the mounting of all the components (as weight increases MDF is not a good choice) then we proceed to glass fiber and this is the most popular material used for maiden flights and testing.

The glass fiber is cut using CNC. The 3D cad model will be converted into a G-code using the slicer software given by the CNC manufacturer. it hardly took 20mins to cut a frame in any of the mentioned manufacturing methods

The figure 3.2.5 below shows the cut parts for initial prototype, for the final product we will use Carbon Fiber for making the Profit into the market

The bottom plate of the main frame has mounting holes for a special mechanism that holds multiple payloads like tanks and cameras and delivery boxes



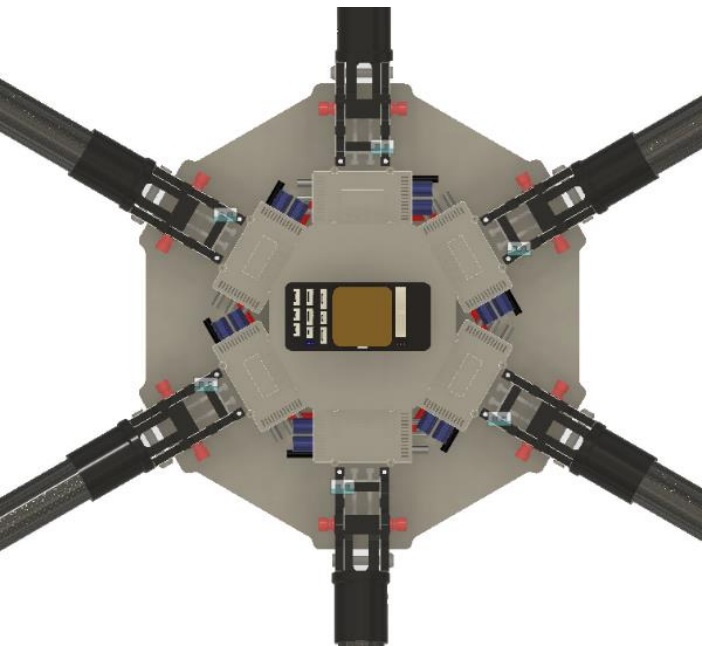
***Fig.4.4.4 GLASS FIBRE MAIN FRAME***

**Fig 4.4.5 Full assembly with delivery payload**

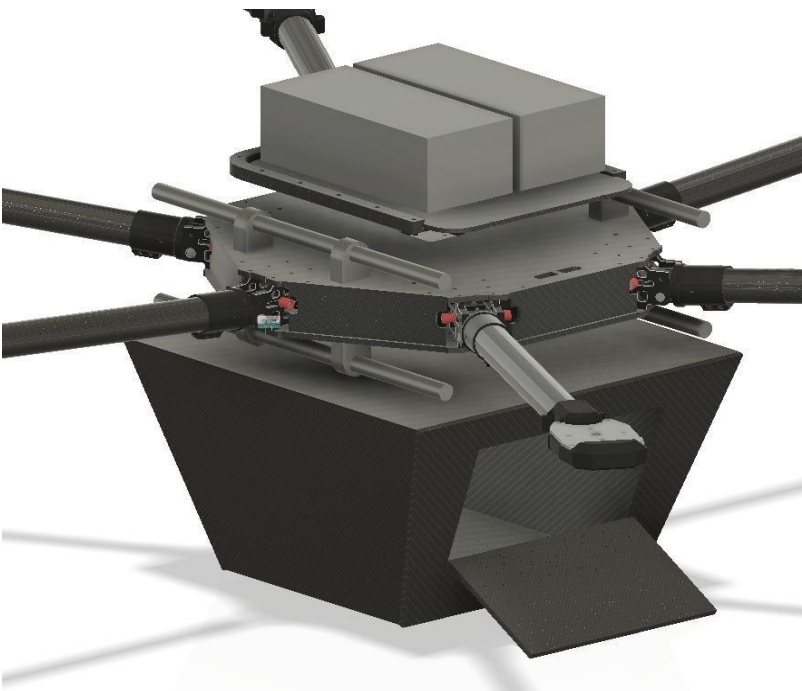


**Fig. 4.4.6 full assembly with canopy**

**Fig 4.4.7 inside components**



**Fig. 4.4.8 side view**



## 4.5 DESIGN OF ARMS

To make the robot simple to convey and consume less space there are 2 different ways to do this, the first is to destroy the robot after each flight and convey it in a little box independently. What's more, the second one is to make the arms and landing gear foldable

We pick the second alternative to simplify the Drone for the client to utilize and convey while guaranteeing the wellbeing of the flight and transportation. The arms are first 2d planned in lowlife and changed over into a 3d model. When the 3d model is done we have picked the aluminum aviation grade (aluminum 6063) amalgam to make the foldable arm joint. We have picked this specific compound since its broadly utilized in the airplane business and well as it offers great in general strength ..

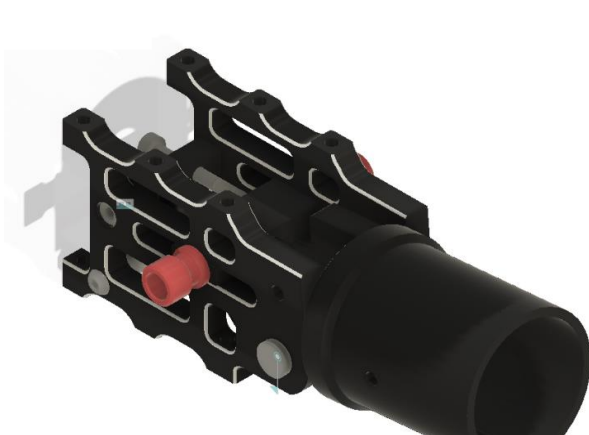
As you can see in the Fig. 4.5.2 We have additionally added a locking instrument to guarantee the arms stay straight up all through the whole flight. We have likewise given a 5-degree upward point to accomplish a steady flight. In airplane wing elements we explicitly have 2 essential setups

### 4.5.1 Anhedral

Anhedral wings will initiate move shakiness and improve move mobility. In an enormous/hefty aero plane with a high-wing setup, there is typically overabundance move dependability, so this kind of wings can be quite normal.

### 4.5.2 Dihedral

In flying, dihedral is the point between the left and right wings of an airplane. "Dihedral" is moreover wont to portray the impact of sideslip on the moving of the airplane. The dihedral point is that the upward point from the middle line of the wings or tailplane of a fixed-wing airplane.



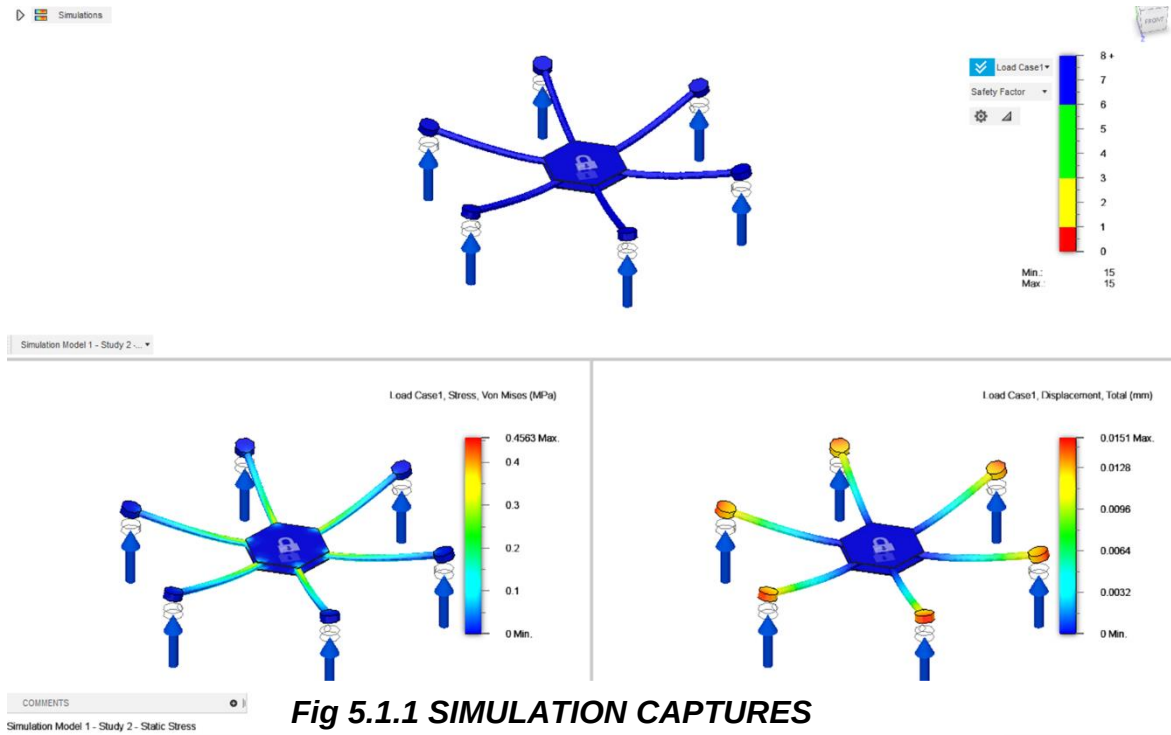
**Fig.4.5.1 UNFOLDED ARM**



**Fig.4.5.2 FOLDED ARM**

## CHAPTER 5

### 5.1 STRESS, STRAIN and SAFETY FACTOR ANALYSIS AND SIMULATION



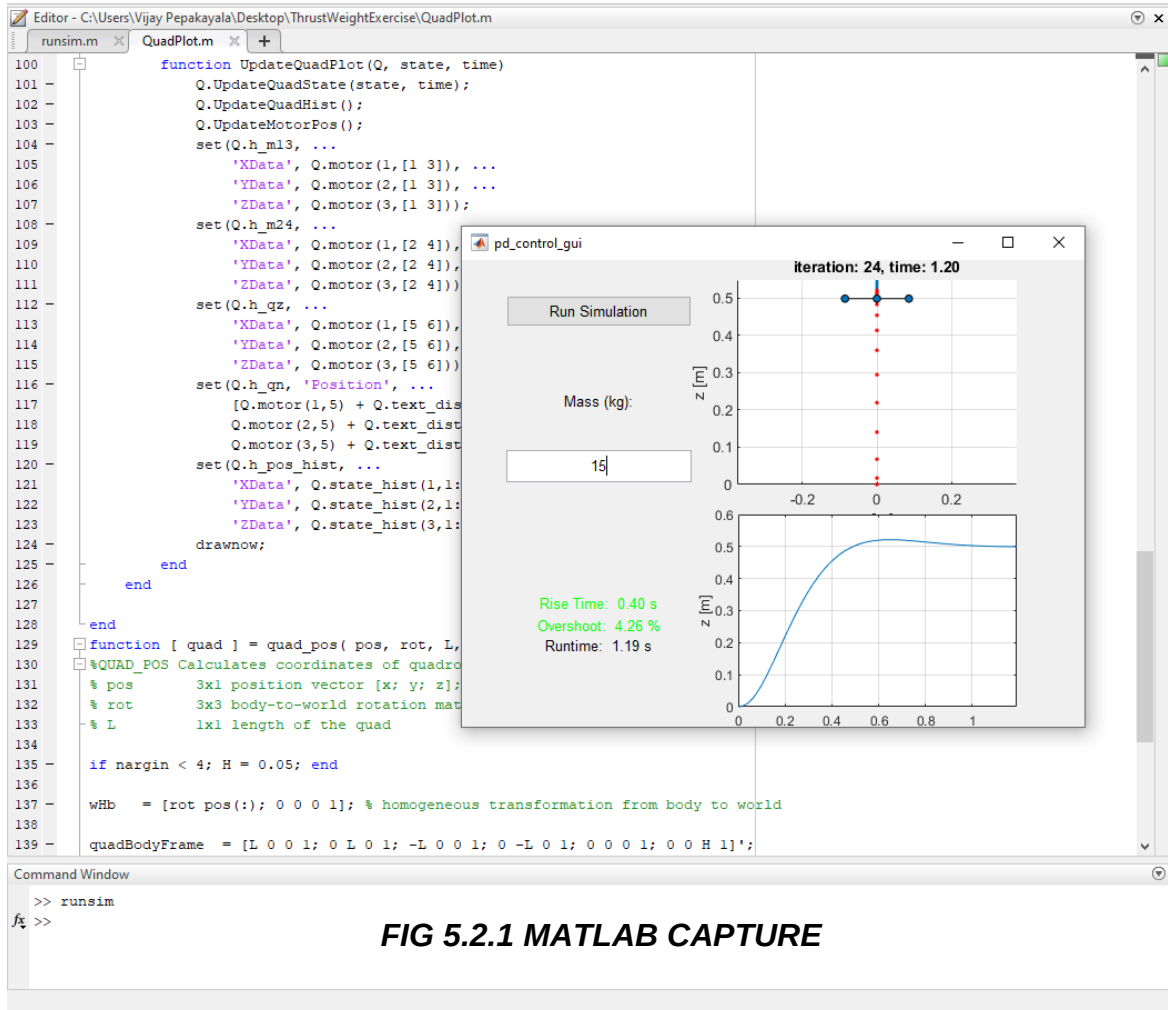
As a fundamental plan we utilized combination 360 to demonstrate an essential Hexacopter with every one of the important computations. Also, not long after some exploration and configuration measure we had improved the last casing with every one of the essential highlights like, mounting of battery and mounting of numerous arrival gear. additionally, we have given sufficient mounting space for all the on-board gadgets and extras like the collector.

The edge has a top plate and base plate and 6 engine mounts and the 6 foldable arm mounts with a sliding instrument on top and lower part of the casing for simple trading of payloads and batteries.

We pick glass fiber are the material for our principal casing and carbon fiber for the bars. For the poles, we pick aluminum aviation grade since aluminum has better twisting properties when contrasted with different materials.

Stress, strain and wellbeing factor investigation is finished utilizing Autodesk CFD and the were very useful in understanding the continuous robot underlying cutoff points and assisted us with shielding the robot with no disappointments. The general security factor was 8 which is great.

## 5.2 MATLAB SIMULATIONS



Along with structural simulations we have also carried out MATLAB simulations for the control and stability of the copter. MATLAB simulations ensure that the model is fit to fly in the real-time environment with a given set of mathematical data like the battery MAH, motors thrust, etc. As you can see the simulations shows that the drone with a mass of 15kgs is airborne within 1.19seconds and that's really great results.

### 5.3 ASSEMBLY

After all the plan cycle and recreation is done, we have our hardware and instruments to gather the hexacopter. We utilized soul levels to change the arms to be 90-degree upwards to dodge any sort of yaw mistakes. We used to heatsink to conceal every one of the wires and mt60 pins to interface the engine wires to the ESCs and the xt90 pins to associate the ESC to the force disseminations sheets. Here's a table to the quantity of screws used to amass this edge.



**Fig 5.3 FULLY ASSEMBLED FRAME**

**Table -3: List of screws**

| S.no | Screw size                            | Multiples           | No. of Screws |
|------|---------------------------------------|---------------------|---------------|
| 1    | Motor mounts to Motor (M4*8)          | 6motors*4screws     | 24            |
| 2    | Arm Mount to the mainframe (M3*8)     | 6 Mounts*12Screws   | 72            |
| 3    | PDB to the main frame (M3*8)          | 1PDB*6Screws        | 6             |
| 4    | Top to bottom plate attachments(M3*5) | 6screws             | 6             |
| 5    | Battery tray assemble (M3*15)         | 8 screws            | 8             |
| 6    | Battery tray locks(M5*2)              | 2 screws            | 2             |
| 7    | Arm mount locks(M3*8)                 | 6 screws            | 6             |
| 8    | Propeller to Motor(M3*12)             | 6 props * 4 screws  | 24            |
| 9    | Motor mount screws                    | 6 mounts * 8 screws | 48            |
|      |                                       | <b>Total</b>        | <b>196</b>    |

## CHAPTER 6

### 6.1 SUMMARY & CONCLUSION

Subsequently, in this manner a substantial and various payload Hexacopter is planned utilizing combination 360, reproduced utilizing Autodesk CFD, fabricated on a CNC cutting machine, amassed in a little lab lastly airborne via conveying a payload of 15kgs and has a perseverance of 35mins max. this robot will be its most amazing aspect its sort and when contrasted with market drones this robot will be an extraordinary item with its great highlights to overlap and open easily and the ease of use it gives just as the self-governing flights it can do are fantastic.

The application fields of multirotor have been expanding regular all around the planet. There are possibilities of such new and arising innovation in the Asia and Asia Pacific area for financial turn of events. For agricultural nations, utilizing helicopters and other enormous airplanes for various purposes like catastrophe the executives, salvage activities, and so on is a test as they have low capital pay for these sorts of things. Essentially, such missions likewise incorporate high possibilities danger of living souls. As another option, the created SIST-Copter utilizing the edge privately made of Carbon Fiber and off-the-rack bought electronic parts is entirely steady, strong, simple to work and kept up. After a heaps of adjusting and bunches of dry runs with every one of the conditions that should be withstood on the site, the robot is prepared to departure with every one of the appropriate payloads referenced above with an exact flight. The Drone is likewise furnished with safeguard to evade any dangers in the midst of installations.



**Fig 6.1 Flying**



**Fig. 6.2 Closeup**



**Fig. 6.3 fully Folded**

**TABLE 4: FEATURES OF THE FRAME AND DRONE**

| <b>parameters</b>                 | <b>Values</b>                     |
|-----------------------------------|-----------------------------------|
| <b>Maximum takeoff Weight</b>     | 40 kgs                            |
| <b>Economy payload</b>            | 12 kg                             |
| <b>control radius</b>             | 3kilometers                       |
| <b>maximum flight height</b>      | 120meter (as per DGCA guidelines) |
| <b>hovering time (no load)</b>    | Up to 35 min                      |
| <b>flight mode</b>                | GPS, Alti, POS, LOS, Failsafe     |
| <b>working temperature</b>        | 0~60°C                            |
| <b>N.W.</b>                       | 15 Kg                             |
| <b>spraying width</b>             | 3~4meter                          |
| <b>spraying speed range</b>       | 3~8meter/S                        |
| <b>efficiency of spray</b>        | 667-1330SQM/min                   |
| <b>spraying height</b>            | 1.2~3meter                        |
| <b>average spray area per day</b> | 166750SQM/day(6hour)              |
| <b>flow rate of nozzle</b>        | 1.2~1.3L/S (adjustable)           |

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