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Design and Analysis of Light Weight Agriculture Robot

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Abstract- Agriculture is the main source of food for human beings living on earth. The farmer who works in field facing lots of problems due to lack of machinery equipment and human labour. Agriculture robot which is light in weight, having high payload capacity with high speed and stability all these can be controlled in field using programming techniques fully. The body frame of Agriculture robot is made of glass fiber, which is lighter in weight and strength to weight ratio is high compared to the conventional materials like steel or aluminum.

A dynamic model for a multipurpose Agriculture robot which is made of flexible parts will be developed. Drone acts as the main body controlling all works in fields providing the tasks which are controllable. Agriculture robot main task is to perform seed sowing of any agricultural crop mainly we have done work on maize crop. Agriculture robot may be further developed accordingly for the applications of other crops like cotton, mango, onions, and groundnut and also developed for Can performing tasks like plants spraying, cutting, pitting holes, harvesting, security causes, and inspecting crop. In air Agriculture robot works with all necessary operations of Pitch, Yaw and Roll and covers the future applications in different Missions.

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DESIGNANDANALYSISOFLIGHTWEIGHTAGRICULTUREROBOT

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Design and Analysis of Light Weight Agriculture Robot

Shaik Himam Saheb[α] & Dr. G. Satish Babu[σ]

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I. Motivation

The motivation of the project is Pesticide spraying drones, these drones are the first one which have generated us an idea to make a drone which is also useful for seed sowing purpose also.

PESTICIDE SPRAY WITH DRONE

Farmers are now started using drones for pesticide spraying, Drones can lift around 15 liters of pesticide at one time and cover a pretty large area in one go. This makes it easy for the farmers as he just has to program the drone and left it fly over the field in pre-defined patterns to cover the maximum area with pesticide this is turning out to be a very fast and efficient way of spraying pesticides and also safe as farmer does not inhale the toxic fumes. In India as individual farms are small and use of drones is useless there many companies have equipped with drones. A group of farmers can get together and rent this drone from these companies and spray in their field [1].Thus the idea was generated in our mind why can't we use these type of Drones in Agricultural fields, then we started developing our initial idea and researched finally now transformed as an agriculture robot.

II. About The Project

We have Titled our project as AGRICULTURE ROBOT which is a combination of a Quadcopter and a Seeding System, we had synchronized a seeding system to a X configured quadcopter.

Thus the combination of these two equipments results in the formation our AGRICULTURE ROBOT. Now a brief explanation about Quadcopter and Seeding System Quad copter otherwise called quad rotor helicopter or quad rotor is a multi rotor helicopter that is

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lifted and pushed by four rotors. Quad copters are named rotor make, rather than settled wing flying machine, on the grounds that their lift is created by an arrangement of rotors. In a quad copter, two of the propellers turn one way (clockwise) and the other two turn the other way (counterclockwise) and this empowers the machine to float in a steady arrangement. Right off the bat the engines which we utilized have a conspicuous reason to turn the propellers. Engines are appraised by kilo volts, the higher the kV rating, the speedier the engine turns at a consistent voltage. Next the Electric Speed controller or ESC is the thing that advises the engines how quick to turn at any given time. We require four ESCs for a quad copter, one associated with each engine. The ESCs are then associated specifically to the battery through either a wiring outfit or power circulation board. Numerous ESC1s accompany an inherent battery eliminator circuit (BEC), which enables you to control things like your flight control load up and radio beneficiary without interfacing them straightforwardly to the battery Our Quad copter utilizes four propellers, each controlled by its own particular engine and electronic speed controller and appropriately modify the RPM of each engine so as to self-balance out itself. The Quad copter stage gives security because of the counter pivoting engines. For Hovering over the skies the Micro controller which is utilized is the „brain" of the quad copter. It houses the sensors, for example, whirligigs and quickening agents that decide how quick each of the quadcopter" engines turn and passes the control signs to the introduced Electronic Speed Controllers (ESCs) and the blend of these signs trains the ESCs to make fine changes in accordance with the engines rotational paces which thusly settles the craft.[2]

As the Quadcopter is synchronized with the Seeding System, whenever the drone flies it will take on the seeding equipment into the air and this system is taken to the place where the seed to get placed or sowed, if the system once reaches the point where to be seed Sowed then the Drone is taken down and when the seeding system hits the ground, then the seed will be got placed on the required spot. Thus AGRICULTURE ROBOT can perform the seed sowing process.

III. Schematic Diagram of Drone

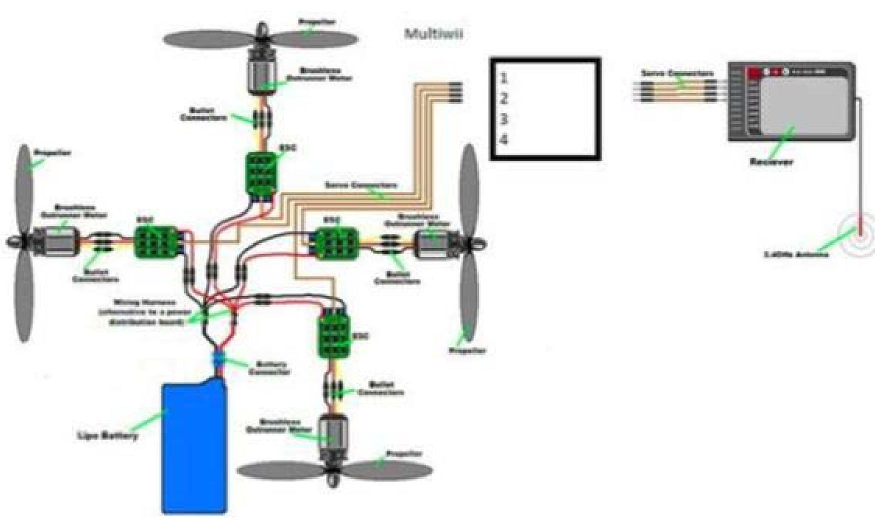

Figure 1.2: Block diagram of Drone

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a) Components used for Drone

Table 1.1: Components of Drone

1	Quadcopter Frame	1
2	ESCs	4
3	Brushless motors-1400KV	4
4	Propellers	4
5	Arduino Uno Microcontroller	1
6	Fly sky Transmitter and Receiver –CT6B	1
7	Battery and charger	1
8	Connectors	8

IV. Objective of the Project

The goal of our project is to design, implement, and test a stable flying AGRICULTURE ROBOT that can be used for Seed Sowing. Through this we can made a less affordable device which will be worked for agricultural purpose mainly for seeding Through this we can reduce the working time of a labor in agricultural field for seeding purpose

The final AGRICULTURE ROBOT design had to meet the following specifications:

1. The AGRICULTURE ROBOT must be capable of flying and landing in stable manner.
2. The Seed Sowing process must be done perfectly.
3. Synchronization of quadcopter and seeding system should be done without any imperfection.

a) Problem Definition

There is a lot of reduction rate in labor or human in agriculture in India today as per environmental conditions. Agricultural farmers work with both labour/human with many different types of farm machinery that are used to help with soil preparation, crop planting, harvesting and crop processing. This machinery is highly expensive giving less production rate. Therefore many researchers have been going through worldwide for development in technology in agriculture. There are machines in agriculture working on ground but they are so heavy can‟t be used more & more times which may damage the crop/fields. Each machinery that present in agriculture requires at least one operator. These machinery work depending on season/crop basis only.

On other hand our Agro Bot is light in weight, can work in any type of conditions, It is one man operatable no need of any extra human efforts, completes the work in time, less in cost, high life span, with higher efficiency compared to present machines and labour, can do any work easily, works on battery which is environmental friendly. Useful in all type of works(multiple functioning).the recent successful application of these drones in spraying and ambulance services military operations etc, in Germany and many developed countries used this technology but to only of half part.

Many more large research works are being under going on this technology which is future scope of mankind.

b) Project Plan

The project plan was divided into five major milestones each spaced approximately Ten days apart.

1. Project Description and Plan of Work
2. System Model
3. Components Purchasing
4. Implementation / Hardware / Software
5. Working on field with the working prototype

The sequence that we met these milestones was out of sequence with the required milestones. Experience told us to get the hardware done as soon as possible as this is often requires a lot of time. By doing so, and because of unforeseen difficulties, we fell behind slightly with the System Modeling and flight Controller. After working closely we were able to complete the milestones only slightly behind schedule

c) Limitations

Our Agriculture robot has some of the limitations which may not be considered as major difficulties, on going through our work we have found some disadvantages our product, they are mentioned below.

1. The main limitation of our product is, the seeds in the seeding system are sometimes jamming therefore regular seeding is not taking place.
2. Whenever the seeding system touches the ground for seed sowing, then the balancing of drone is not adjusting i.e. situation of non balancing of drone occurring.
3. Since we have done a small seeding system the numbers of seeds that are inserted in the seeding system are less.

V. Literature Review

a) Introduction

This chapter will explain about the research of the project that has been chosen and explained about the history of go kart. It will review the basic components of the system itself.

The AGRICULTURE ROBOT project required extensive research into UAVs and several mechanical

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mechanisms, and similar systems. By reviewing others work, we used this insight to develop our system. To this end, research papers from various quadrotor groups were used as guides in the early development of the dynamics and control theory.

b) Existing System

QUEENSLAND agriculturists would now be able to utilize automatons to splash edits after enactment was revised to grasp the innovation. Acting farming pastor Bill Byrne said the innovation would be particularly valuable for applying chemicals in territories with restricted access or troublesome landscape [3].

c) Aerial Sprayer

Aeronautical sprayer is another kind of splashing it is advantageous for the agriculturists having vast Farms. This method by ranchers is not moderate to agriculturists having little and medium homesteads. In aeronautical splashing the showering is finished with the assistance of little helicopter controlled by remote. On that sprayer is joined having numerous spouts and splashed it on the homestead from some height [3].

Figure 1.3: Showing Aerial Sprayer

VI. Description

Indian agriculture needed production and protection materials to achieve high productivity. Agriculture fertilizer and chemical frequently needed to kill insects and growth of crops. The WHO (World Health Organization) estimates there are more than 1 million pesticide cases in every year. In that more than one lakh deaths in each year, especially in developing countries due to the pesticides sprayed by human being. The pesticide affects the nervous system of humans and also leads to disorders in body. A remote controlled UAV (Unmanned Aerial Vehicle) is used to spray the Pesticide as well as fertilizer to avoid the humans from pesticide poison. The UAV is operated by manual flight plans and the Sprayer is manually triggered by RF controlled Nozzle. The vertical take-off and landing quadcopter is used to spray the low volume pesticide in a small area. This project describes the development of quadcopter UAV and the sprayer module. And also discusses the integration of sprayer module to quadcopter system. This model is used to spray the pesticide content to the areas that can't easily accessible by humans. The Universal Sprayer system is used to spray the liquid as well as solid contents which are done by the universal nozzle. Multispectral camera is used to capture the remote sensing images which are used to identify the green fields as well as the edges of crop area. Total payload liftoff weight of quadcopter is 8 kg. Remote sensing images are analyzed by QGIS software [3].

a) Quadcopter Working Principle

The quadcopter is simple design with four rotor propellers with controller (Figure 3). The flight controller is the main part of this vehicle. This ardu pilot controls all the operation commanded by us. The four rotors to create differential thrust and the quadcopter hover and move accordance with the speed of those rotors. There are two types of configuration in quadcopter construction. First one is Plus (+) configuration and another one is Cross (X) Configuration. In this project we used X (Cross) configuration. Both the models are same, but the control of these models slightly different. The cross configuration is easier than plus configuration model. Total mass to lift is 4kg means, the total thrust produced by rotors should be 8 kg. GPS guidance system is used here to navigate the UAV. Pre-Loaded trajectory gives the real time coordinates to ardupilot controller. Based on this GPS coordinates, the microcontroller navigates the UAV [3].

b) Sprayer Module

Sprayer module has two sections, they are 1) Transmitter section (Remote controller), 2) Sprayer with controller. Transmitter section used to control the actuator of sprayer module. The nozzle of sprayer module will be activated by remote control. Wherever need to activate the sprayer, just comment by remote RF transmitter. Sprayer module contains two sections, spraying module and controller. Spraying module contains the spraying content i.e., pesticide or fertilizer and the controller section used to activate the nozzle of sprayer. The command is received from remote controller which is activated manually. Tank contains the chemical content which is going to spray on crops that may be a pesticide or fertilizer. The Nozzle of the sprayer module will be activated by GPS device. This GPS module having the preloaded GPS coordinated, Liquid Pump Motor with Tank. The spraying pump overflow rate is max, 1L/minutes. The maximum spraying height is 4 meters. Flying speed is max. of 5m/s. It covers 2m range of green fields with compatible land edge Coverage Rate [3].

c) Advantages

1. This method can be used in all situations, especially in the places where labours are hard to find [3].
2. Environmental pollution can be reduced when it sprayed from lower altitude [3].

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3. It has a great potential to enhance pest management for small as well as the large crop field to entail highly accurate site-specification application [3].

d) Disadvantage

The aerial sprayer system is only used for the purpose of spraying of pesticides, this may not considered as a disadvantage but seed sowing is also a major work done by farmers in agricultural field. In order to reduce that work our system is developed as per conditions.

e) Proposed System

On researching several journals and many UAV systems we have take down a step to introduce a new system in the field of agriculture which will have an unique application. So we have gone through check on what work in agriculture field there are no mechanical system is used is the application that is required by the farmers, by many surveys we have came to known that there is no proper device or machine for SEED SOWING. Hence we have concluded to do a machine that is applicable in the process of seed sowing, so as per required conditions we had designed our system and we named it as „AGRICULTURE ROBOT‟ and also as „AGRO-DRONE‟.

It is the combination of an UAV and a Seeding System which are synchronized each other that will jointly together to perform seed sowing.

f) Literature Conclusion

So, here we have concluded that Agriculture robot is going to be one of the essential component in the agricultural fields which can performs seed sowing, the most required task for growth of any plant or crops. In this project we are going to fabricate seeding equipment and a drone, those two are synchronized each other to perform seeding in the agricultural field. Thereby we can reduce human effort and working time in the field.

VII. Components And Their Specifications

a) Frame

This is the glass fiber quadcopter frame which is very simple and easy to build frame This Flame wheel is one of the most popular frames out there for a number of good reasons.

1. It is relatively inexpensive
2. It is famously durable
3. The centre plate doubles as a power distribution board which tidies things up quite a bit and allowed me to get rid of my ugly DIY wiring harness.
4. The design is really well thought out – it's a compact frame. Plenty of room for receiver, control board, ESCs, and battery, with mounting options and room to spare for a GoPro or other camera setup.
5. As one of the most popular quadcopter frames on the market, there is a wide variety of spare parts and accessories to choose from such as landing gears, gimbals, etc,

Figure 3.1: Quadcopter Frame

Things to consider here are weight, size, and materials. They're strong, light, and have a sensible configuration including a built-in power distribution board (PDB) that allows for a clean and easy build. There are also a ton of spare parts and accessories available from many different websites. There are also a ton of clones out there, most of which include the same built-in PDB and durable construction as the original. Parts and accessories are 100% compatible and interchangeable.

Frames can also be built at home using aluminum or balsa sheet. But results will vary from manufactured frames, both aesthetically and in terms of flight attributes

b) Motors

An electric motor is an electrical machine which converts electrical energy into mechanical energy. There are two types of motors generally used for drones, they are

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i. *CW and CCW Motors*

Basically the difference of CW and CCW motor is the prop shaft thread rotation. The intention is to use 2 CW motors and 2 CCW motors on a quad, so that when the motors spin, all four prop nuts lock themselves down. It really matter which one you pick as they are identical motors except the prop shaft thread. But I personally prefer to get all motors of the same threads so I don"t confuse myself with the different prop nuts.

Item No.	Volts (V)	Prop	Throttle	Amps (A)	Watts (W)	Thrust (G)	RPM	Efficiency (G/W)	Operating temperature(℃)
MT2216 KV900	11.1	T-MOTOR 10*3.3CF	50%	2.8	31.08	300	5200	9.65	38
			65%	3.7	41.07	360	5700	8.77	
			75%	4.7	52.17	420	6300	8.05	
			85%	6.2	68.82	520	6900	7.56	
			100%	7.4	82.14	600	7400	7.30	
		T-MOTOR 11*3.7CF	50%	3	33.30	350	4900	10.51	40
			65%	4.4	48.84	420	5400	8.60	
			75%	5.7	63.27	530	5900	8.38	
			85%	7.3	81.03	630	6500	7.77	
			100%	8.9	98.79	720	7000	7.29	
		T-MOTOR 12*4CF	50%	3.5	38.85	420	4200	10.81	43
			65%	5.8	64.38	560	5000	8.70	
			75%	7.8	86.58	680	5450	7.85	
			85%	10	111.00	820	5900	7.39	
			100%	12	133.20	920	6350	6.91	
	14.8	T-MOTOR 9*3CF	50%	3.4	50.32	370	7000	7.35	46
			65%	4.4	65.12	410	7800	6.30	
			75%	5.3	78.44	470	8500	5.99	
			85%	7.4	109.52	610	9300	5.57	
			100%	8.5	125.80	700	10000	5.56	
		T-MOTOR 10*3.3CF	50%	4.1	60.68	460	6500	7.58	50
			65%	5.6	82.88	570	7300	6.88	
			75%	7.1	105.08	690	7900	6.57	
			85%	9.5	140.60	830	8600	5.90	
			100%	11.2	165.76	940	9300	5.67	

Notes:The test condition of temperature is motor surface temperature in 100% throttle while the motor run 10 min.

Table 3.1: Motor Power Thrust Data Table

ii. *Motor Specifications*

ABLDC motor (2212/10T, 1400KV)

- No. of Cells: 2 - 3 Li-Poly, 6 - 10 NiCd/NiMH
- Kv: 1400 RPM/V
- Max Efficiency: 78%
- Max Efficiency Current: 6 - 12A (>75%)
- No Load Current: 0.7A @10V
- Resistance: 0.065 ohms
- Max Current: 16A for 60S
- Max Watts:180W
- Weight: 51.5 grams
- Size: 27.8 mm x 31 mm
- Shaft Diameter: 3.2 mm

Figure 3.9: Brushless DC Motor

c) *Theoretical Calculations*

In this chapter we are going to calculate the important parameters of the system which play an essential role in terms of selecting the components, the facrots like capacity, thrust, power, rpm etc. are included in this calculation chapter.

VIII. Calculations for an Esc

a) *Max Amp Rating*

Brushless ESCs are used to control brushless motors that are used on most quadcopters. The maximum amperage an ESC can handle needs to be greater than the motor/prop combination will draw. In terms of ESC, suggesting 20%-50% extra Amps is good rule to ensure your ESC do not burn out. For example Current rating for motor is 22A so ESC you are considering 30A should do fine.

Here is simple formula,

ESC = 1.2-1.5 x max amp rating of motor.

So, we can select ESC between ranges of 26A to 33A.

i. *Voltage from battery*

Make sure your ESCs the ability to withstand the voltage from the chosen battery. If you remember our motor draws max 15amp,So watt value for 3S and 4S will be

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At 3S battery 11.1 x 15 = 166.5 Watt
At 4S battery 14.8 x 15 = 222 Watt

Since our motor and esc are not much efficient in capable of 4S battery we used 3S battery only

Since our motor is of max current 16 Amp and we can take the esc of 30A. Due to reason or formulae

ESC (A) =1.2-1.5×MAX AMP OF MOTOR

=1.5×16 =25.

SO, we have chosen the ESC of 30A.

ii. *Thrust Caluclations (Without Seeding System) of Drone*

General required thrust is given by an formula mentioned below it is

Thrust required = (total weight of setup) ×2/4.

Therefore according to the frame, esc, battery and other set up we are getting a weight of 1300 grams. I.e. frame weight is 950 grams and other will roughly weights of 350 grams

Required Thrust = 1300×2/4
= 2600/4
= 650 grams

Here we get the required thrust for each motor should be 650 grams for each motor.

Now we have to calculate the actual amount of thrust that is going to produced by an individual motor.

According to some sources i have found that the thrust generated by motor ia given by following formula

$$T= [(eta \times P)^2 \times 2 \times pi \times r^2 \times air\ density]\ ^\wedge ⅓$$

Where,

Eta = prop hover efficiency let us take it as 0.7-0.8

P= shaft power

= voltage ×current ×motor efficiency

R = radius of propellers in meters

Air density =1.22kg/m³ Voltage = 10v

Current =16A

Motor efficiency =75%=0. 75

Eta=0.7

Then, thrust is

$$T=[(0.7\times10\times16\times0.75)^2\times2\times3.14\times0.127^2\times1.22]\ ^\wedge 0.33$$
$$= [(84)^2\times0.123]\ ^\wedge 0.33$$
$$= (7056\times0.123)\ ^\wedge 0.33$$
$$= 871.92\ ^\wedge 0.33$$
$$= 9.348\ N$$

Therefore Thrust calculated

T = 9.348N
= 9.348×0.101 Kg
= 0.943kg
= 943 grams

Hence, the thrust generated by each motor = 943 grams

Since we have 4 motors in the quadcopter, the total thrust generated by all motors is given by multiplying, thrust with 4

Total thrust T = 943×4 grams
= 3772 grams
T = 3.772kg.

If we again choose any less efficiency in motor then we will take some factor of safety, if they work only 70% efficient in the above 70% efficient work we can produce thrust of Thrust T = 3.772×70/100

T = 2.64kg

Therefore the min to min amount of thrust produced by all the motors is 2.64kg

iii. *Thrust Calculation (With Seeding system) of Agriculture Robot*

Required Thrust when we assemble the seeding equipment to the drone. It will be given by

T2= (weight of drone +weight of seeding equipment) ×2/4

T2 = (1300+400) ×2/4
T2 = (1700×2)/4
T2 = 3400/4
T2 = 850 grams

Since the thrust produced by individual motor is 943grams, that thrust is greater than the amount of thrust required with the combination of drone and seeding equipment, so our system will be in safe condition and work effectively.

b) Battery Calculations

We have to calculate the amount of energy it is consuming; hence we have now calculating the source required by the battery.

Max source = discharge rate*capacity
= 20×2200
= 44000
= 44Amp

i. *Discharge Rate*

Discharge rate is simply how fast a battery can be discharged safely. In the RC Li-Po battery world it is called the "C" rating. Remember we should never discharge a Li-Po BATTERY BELOW 80% OF ITS CAPACITY.

So, the max source i.e. ESCs should not exceed 44A, since we have selected a 30A ESC there is no problem, it is perfect battery.

ii. *Propeller Calculations For Thrust*

We have,

Payload Capacity + The weight of the craft itself = Thrust * Hover Throttle %

For example, If you choose 3s Lipo battery to supply power. your propos is 10*4.7 and throttle is 75%.The weight of the craft itself is 1700g and we, want to build our quadcopter which can load 1000 grams.

1000+1700 = T×75%
T = 2700/0.75
T = 3600grams

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This amount of thrust should be provided by 4motors, so we can calculate individual thrust required by

T = 3600/4

T = 900grams

Since the thrust required is 900grams, as we calculated above thrust produced or generated by each motor is 943 grams. The system will be safe or run without any default.

Finally we have concluded to select the 4 propellers of size 8×4.5 inch which 2 are supposed to CW and others for CCW. And they weight of 14gram per pair, so total weight is 28gram

IX. Design of Quadcopter

a) Introduction

The design of Quadcopter has been done by using CATIA V5 software. The design is done in such a way that there should not be any damage to the propellers, motors and mechanical equipments. The central hub, spars and the arms are designed individually and assembled. CATIA V5. CATIA is able to read and produce STEP format files for reverse engineering and surface reuse.2D structural parts of quadcopter central hub 3D Design of the Quadcopter parts 3D central hub Arm International Journal of Scientific & Engineering Research, Assembly of the Arm and Central hub complete assembly of the Arm The 2D view of the arm is drawn in the catia v5 software and it is converted in to 3d view by giving thickness of 20mm. like wise the arm stand and the knife edge curvature is designed and converted it in to 3D view. The three parts can be designed individually or at a time by creating another plane on the side wich we need to add the futher design. After sketching that part on the plane and it is converted in to 3D by using 3D tool bar. Scientific & Engineering Research, 6 assembly of central hub and arm.The both parts are sketched and designed individually.

b) Analysis

Analysis of Quadcopter design Analsysis of thr parts of the designed quadcopter is done by using ANSYS software. Ansys software is the tool of the FEM analysis. Here we are going to make the analysis of the material by using carbon fibre. The parts are meshed first analysed with the specific boundary conditions and various loads Forces based on motor basis.

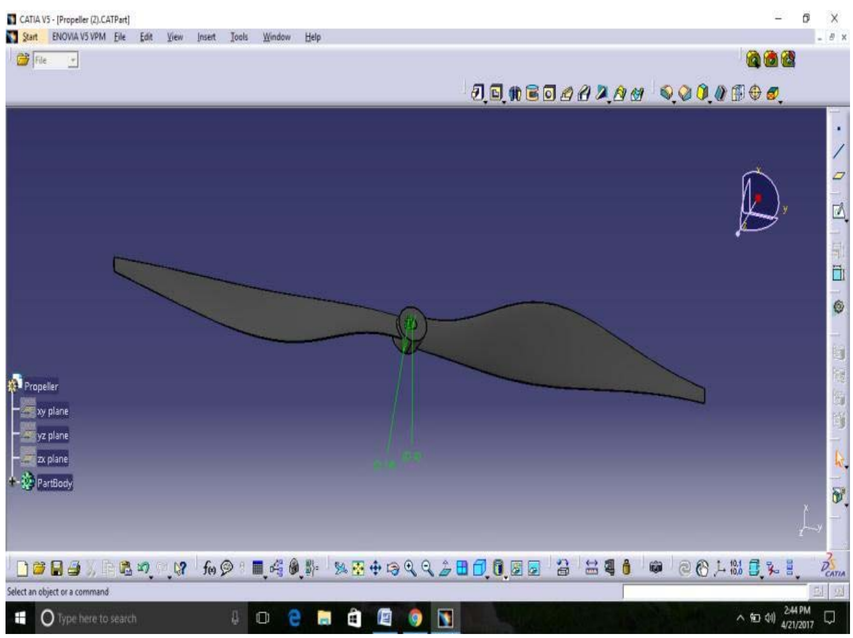

Figure 5.1: Design of Propellers

i. *Design of Propellers*

- Length of Propeller = 80mm
- Pitch diameter of propeller = 45mm
- Shaft hole diameter = 12mm
- Thickness of propeller = 0.3mm

c) Ground Chasis Plate Dimensions

Part design involves designing of parts individually and using different workbenches like

1. Product Structure
2. Assembly Design
3. Generative shape design
4. Drafting
5. Material Library
6. Sketcher
7. KOM
8. Sheet metal

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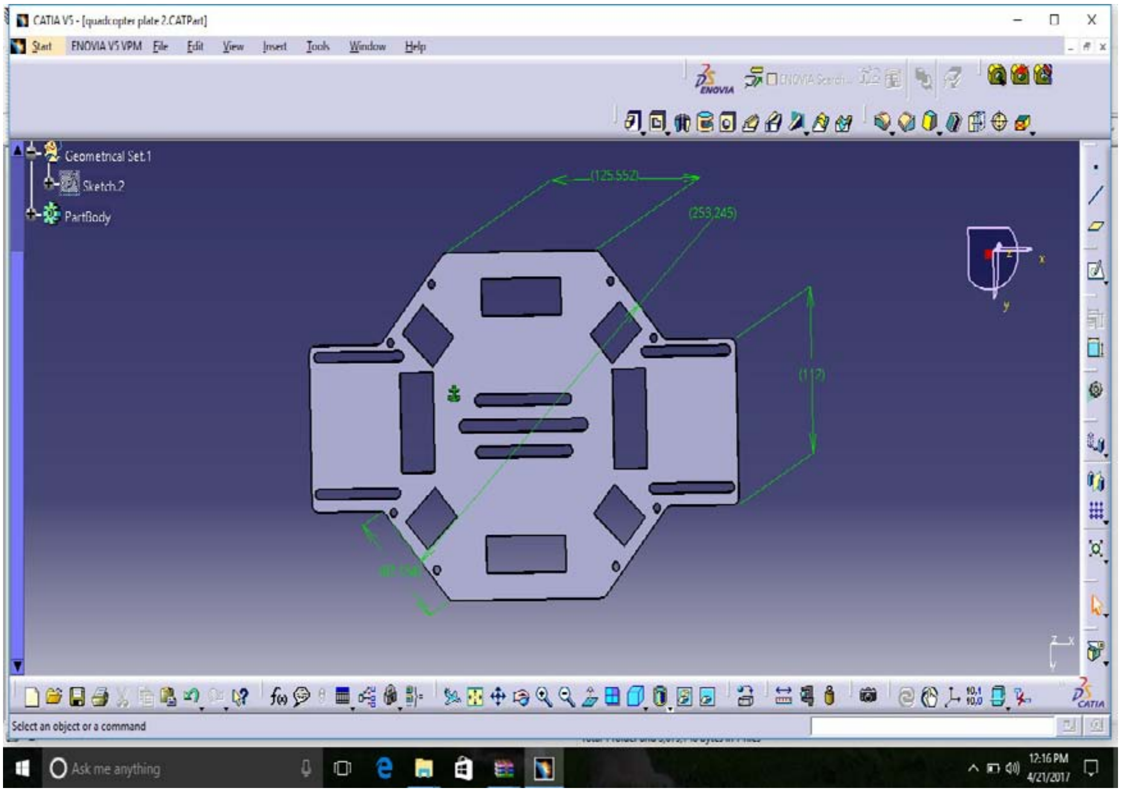

Figure 5.2: Frame of Quadcopter

Horizontal length = 360mm
Vertical length = 234mm
Cross length = 82mm
Cross sectional length = 253mm

d) Chassis of Quadcopter

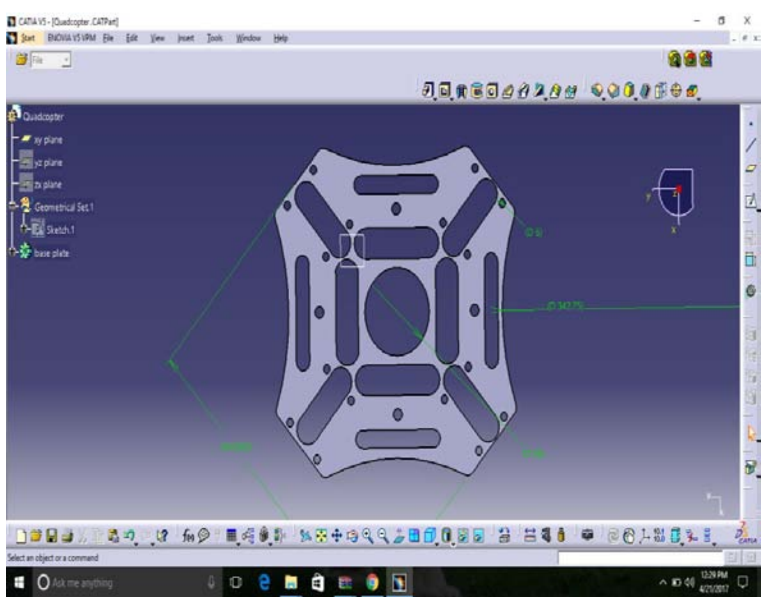

Figure 5.3: Chasis of Quadcopter

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i. *Design of Upper Plate*

Outer diameter cut section = 110mm Nut diameter = 6mm

Inner circle diameter = 30mm Vertical length = 80mm Doughnuts = 0.8cm

Drone electrical architecture. The underlying system for the quadcopter in this thesis is named the" Marq Drone" system. This system consists of a flight controller, a radio, and ESCs. Core components of the flight controller include a micro-controller unit, a radio, and an inertial measurement unit. The flight controller communicates with the ESCs through pulse position modulation. More information about PPM can be found here. In addition to communicating with ESCs, the flight controller communicates with a lidar sensor through a universal asynchronous receive and transmit interface. To communicate with devices external to the quadcopter, a USB interface can be used for data acquisition or programming. Another communication method is through a wireless 2.4GHz frequency shift keyed interface for receiving flight commands and transreceiving flight data. Now that all the components involved have been introduced, the I/O of the system can be identified. For the flight controller itself, feedback inputs are from the IMU, sonar, and lidar sensors. The outputs of the system are the four individual PPM signals that are sent to the ESCs. Now that the I/O of the system has been briefly introduced, a control scheme will be derived that uses these I/O to achieve stable flight.

e) *Arm Design*

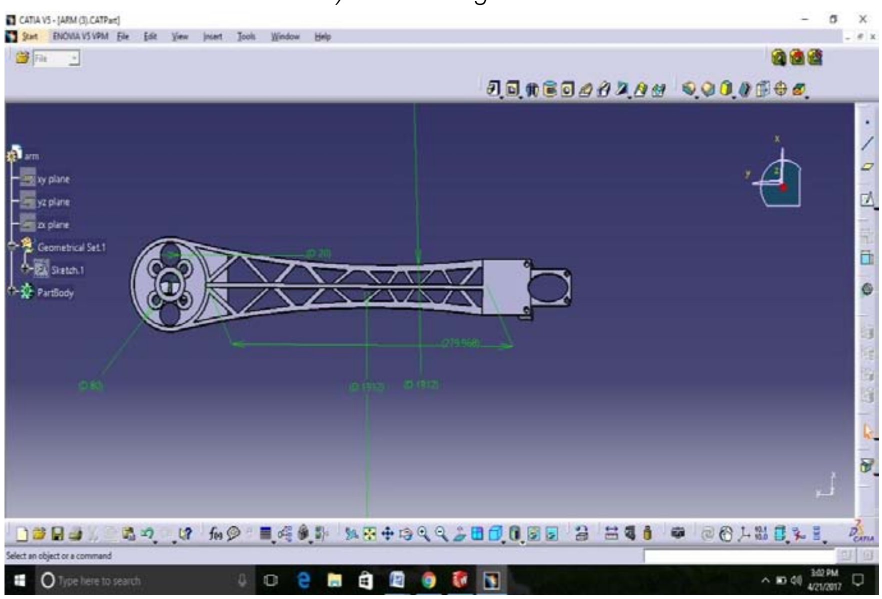

Figure 5.4: Frame part of Quadcopter

Breadth length of arm = 37mm Thickness of arm = 3.7mm

Total Length of arm leg = 150mm Arm leg length = 50mm

Arc curve diameter of leg = 2.4mm

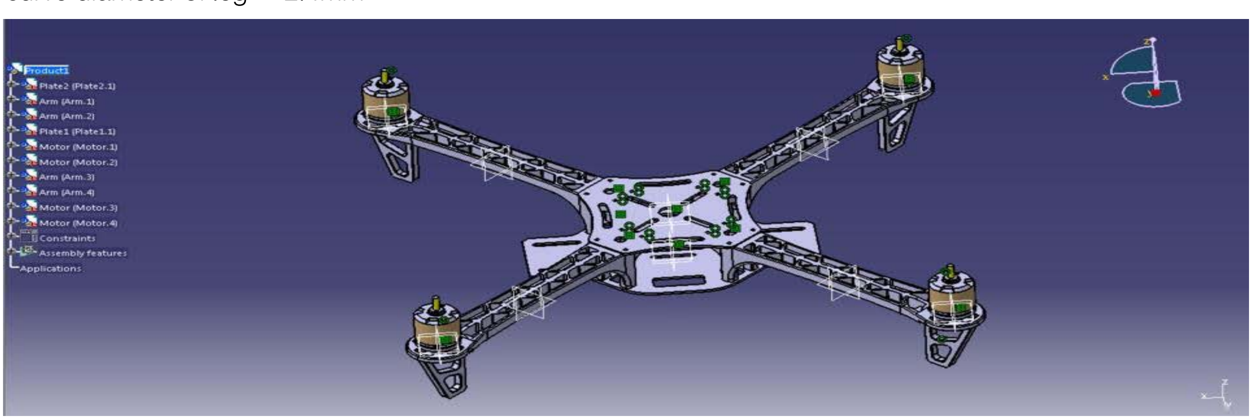

Figure 5.5: Assembly Design of Drone

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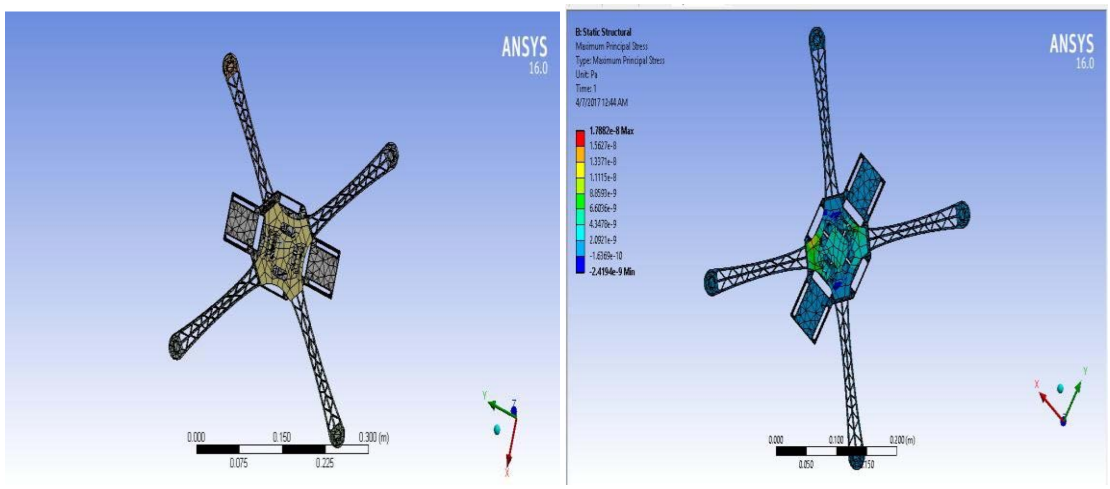

Figure modal and structural analysis of Quadcopter

f) Analysis load data

In Agriculture robot we have undergone modal analysis and structural analysis with different load conditions and forces. we took a force & load of 100KN,200KN,300KN which gave positive results mesh analysis of whole body with stress and strain at every corner of the body. Good deformation capacities with height strength as shown in figure 5.6.

X. Project Description

a) Principle of Operation

Frame Principle: Frame is the structure that holds all the components together. The Frame should be rigid, and be able to minimize the vibrations coming from the motors. Quadcopter frame consists of two to three parts which don"t necessarily have to be of the same material:

- The center plate where the electronics are mounted
- Four arms mounted to the center plate
- Four motor brackets connecting the motors to the end of the arm Most available materials for the frame are:
- Carbon Fiber
- Aluminum
- Wood, such as Plywood or MDF (Medium-density fiberboard).

Carbon fiber is most rigid and vibration absorbent out of the three materials but also the most expensive. Hollow aluminum square rails are the most popular for the Quadcopters" arms due to its relatively light weight, rigidness and affordability. However aluminum could suffer from motor vibrations, as the damping effect is not as good as carbon fiber. In cases of severe vibration problem, it could mess up sensor readings Wood board such as MDF plates could be cut out for the arms as they are better at absorbing the vibrations than aluminum. Unfortunately the wood is not a very rigid material and can break easily in Quadcopter crashes. As for arm length, the term "motor-to-motor distance" is sometimes used, meaning the distance between the centers of one motor to that of another motor of the same arm in the Quadcopter terminology. The motor to motor distance usually depends on the diameter of the propellers.

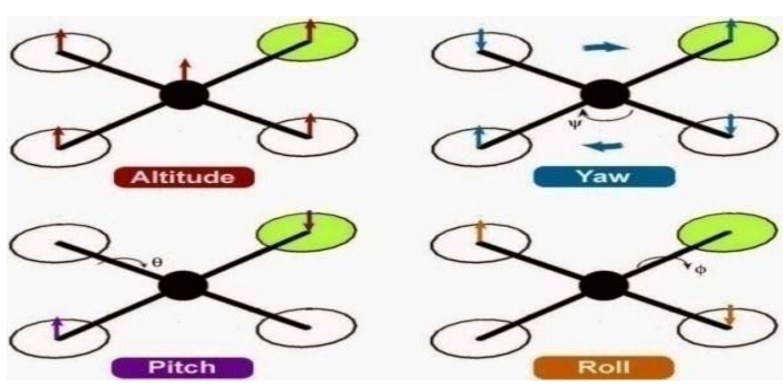

Figure 6.2: Altitude Direction, yaw direction, Pitch direction and roll direction

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XI. Software Analysis

In this project we are using Arduino and Digital Radio Software

a) Arduino Analysis

In the project the program is dumped to the controller through Arduino. Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

The Arduino programming language is an implementation of Wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

b) Digital Radio Software

This is the software which is used to set PID Control Settings. Here we can set the different channels to be used for Radio transmitter and Receiver. Model that is used is MODEL-2. Different types of settings are available as:

1. ACRO 2. HELI-120
3. HELI-90 4. HELI-140

XII. Hardware Analysis

There are different steps to be followed in this analysis.

1. Assembling of Frame
2. Soldering for Chassis
3. Connection of ESC"S
4. Fixing of Brushless motors
5. Propellers fixing
6. Synchronization of Transmitter and Receiver
7. Testing the Quadcopter.

a) Frame

Quadcopter frame can be called as the chassis of the quadcopter. The frame can be achieved in different configurations such as +, X, H, etc…the selection of the frame is totally a user defined choice based on his own purposes.

We used HJ 450 Frame. FlameWheel450 (F450) is a multi-rotor designed for all pilots for fun. It can achieve hovering, cruising, even rolling and other flight elements. It can be applied for entertainment, aerial photography, FPV and other aero-modeling activities. When flying, the fast rotating propellers of FlameWheel450 will cause serious damage Safety precautions to be taken are:

1. Keep flying multi-rotor away from objects, such as obstacles, human beings
2. Do not get close to or even touch the working motors and propellers, which will cause serious injury.
3. Do not over load the multi-rotor.
4. Check that the propellers and the motors are installed correctly and firmly before flight.
5. Make sure the rotation direction of each propeller is correct
6. Check whether all parts of multi-rotor are in good condition before flight. Do not fly with old or broken parts.
7. Use DJI parts as much as possible.

Figure 6.6: Axis Frame

b) Soldering

Chassis which is inbuilt with frame has to be soldered for connecting ESC"S. Chassis works as a printed Board for power supply. We have used Insulating material for soldering. While soldering we must make sure that there is no open or close circuit.

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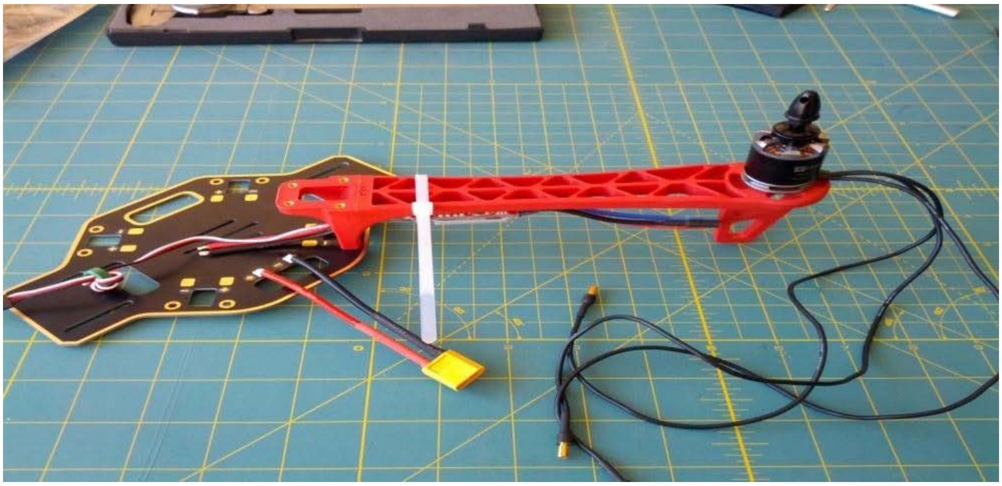

Figure 6.7: Soldered Chassis

XIII. Seeding System

a) *Introduction*

Maize is one of the important foods, green forage and industrial crops of the world. It is called QUEEN OF THE CEREALS. Maize has highest yield/ha among the cereal crops. It is now grown in all countries except Antarctica and under a more varied range of climates than any other cereal crops. The National Commission on Agriculture observed that maize can substantially contribute to the additional total food grain production by increasing its present contribution from 6-7% to 10%. Though it is mainly used as a food crop in India by the rural population in the form of bread and gruel, it has vast industrial potentialities as well having many as 50 different uses. Ex: it can be put to the manufacture of starch, syrup, alcohol, acetic acid, lactic acid, glucose, paper, rayon, plastic, textiles, adhesives, dyes, synthetic rubber, resin, artificial leather, boot polish etc., Corn oil is 4% USES Green ears find a ready market in the urban areas. The grain is ground into flour for making bread. Maize is being used as a poultry and cattle feed. Stover, whether green or dry is fed to the cattle.

QUALITY Grain contains: Protein- 10%

Oil – 4%

Carbohydrates – 70%

Fat – 5 to 7%

Fiber – 3 to 5%

Minerals – 2%

It is operated in such a way that, where we want to sow the seed then it will be taken down and then the seeding system the pipe of the seeding equipment hits the ground then it will be induced to some force and that will moved in vertical direction.

Table 7.1: Maize Seed Details

Means (± standard deviation) for corn plant height, proportion of green ears in the first harvest and green-ear yield values of three corn cultivars submitted to weed control methods[1/]

Method of weed control	Plant height (cm)	Proportion of green ears at first harvest (%)[2/]	Total unhusked green ears ha^{-1}		Marketable unhusked green ears ha^{-1}		Marketable husked green ears ha^{-1}	
			Number	Yield (kg)	Number	Yield (kg)	Number	Yield (kg)
Hoe-weeding	184 (±16.2) a	62.9 (±26.3) a	49167 (±3837) a	14108 (±1607) a	48269 (±4508) a	13857 (±1835) a	44840 (±7,129) a	8474 (±1439) a
Intercropping with cowpea (BR 14 cultivar)	170 (±7.8) b	51.6 (±18.6) b	48974 (±1198) a	11447 (±959) b	45128 (±1370) a	11038 (±1288) b	37051 (±4348) b	6305 (±1008) b
Intercropping with cowpea (IPA 206 cultivar)	176 (±16.7) ab	46.0 (±18.3) b	48846 (±1905) a	10389 (±1512) b	45585 (±5133) a	10205 (±1811) b	34935 (±8429) b	5701 (±1447) b
No weeding	173 (±16.4) b	52.8 (±25.9) b	47180 (±2275) a	11545 (±2366) b	44344 (±4976) a	11199 (±2337) b	36923 (±11007) b	6310 (±1853) b
Means of corn cultivars	175.8	53.3	48541	11872	45832	11575	38437	6698
Coefficient of variation for plots, %	14.1	32.4	3.9	18.2	9.3	18.0	27.1	28.0
Coefficient of ariation for subplots, %	5.9	19.0	5.8	13.0	10.1	15.7	18.7	19.6

[1/] Means followed by the same letter in the column do not differ by the Tukey's test ($P < 0.05$). [2/] In relation to the total number of green ears harvested in the first of three harvests.

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XIV. Area and Production

Among cereals maize crop occupies 3rd place in the world after wheat and rice. America ranks first in productivity followed by Europe. In these areas maize is used primarily as a source of animal feed. Nearly 54% of the total area is located in South America, Asia and Africa, but they contribute only 33% to the total production of the maize in the world. In these areas, average productivity is low. Maize is consumed primarily as a source of human food. India cultivates 5.4% of the total area and provides 1.7% of the total production of maize in the world.1997-98 World India AP Area [mha] 140 6.30 396000ha. Production [million tons] 420 10.85 1084000t Productivity[kg/ha] 3000 1720 2740 In India, UP ranks first in area production while the productivity is highest in Karnataka. Punjab ranks fourth position. In AP, it is intensively grown in North and South Telangana particularly Karimnagar, Medak, Nizamabad, Warangal an Adilabad districts

a) Working

The seeding system working is explained in the below sentences, the synchronized drone and seeding system are arranged and went for testing in the working field, whenever the drone starts flying it carries the seeding system along with that and the drone will be operated in such a way that, where we want to sow the seed then it will be taken down and then the seeding system the pipe of the seeding equipment hits the ground then it will be induced to some force and that will moved in vertical direction.

The pipe has small hole that it is coincided with the other hole which was present on the other pipe, then through that hole the seeds are dropped to the ground.

Then this will make sure that the seed should be dropped at the place where we want to sow. Thus the seeding is completed.

XV. Design of Seeding System

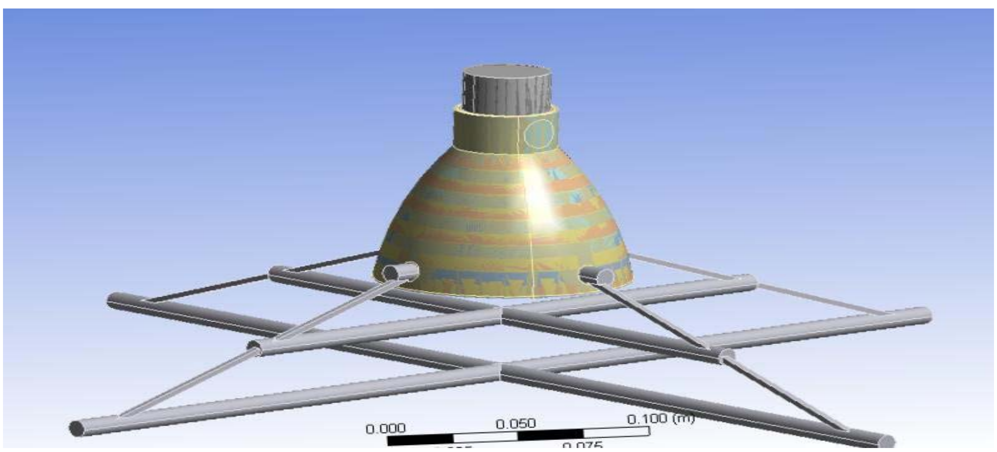

Figure 7.1: Seeding System

a) Applications

The main application of our system and some other extended applications of our system are explained below.

i. *Seed Sowing*

The main objective of our system is to work it as a seed sowing device in agricultural fields, which is a major work in farming. our system performs seed sowing in agricultural lands with high efficiency rate and reduces the working time of labours, we can perform the work done by several humans with our single device.

ii. *Extended Applications*

a. *Aerial Photography*

This application is widely used now a days. Music concerts or any functions where there is large gathering of people, they can be photographed using aerial only.

b. *Military Applications*

1. Tracking
2. Drones with the help of gps can track particular person or vehicle movement
3. Identifying enemy movements
4. In search and rescue operations
5. Many military operations uses drones for live coverage of the mission Rescuing hostages and civilians is the main objectives of these operations. Drones are used to check the condition of the hostages

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iii. *Environmental Applications*

a. *Fire Control Quad Copters*

Fires caused in forests due to various reasons are very difficult to control. These can be controlled effectively by means of drone. Drones will carry water of some sort of solutions. Drone installed with gas sensors helps to detect the amount of gases present in the particular area in the atmosphere. These figures can be stored in the memory card or send to us by using gsm module. For using gas sensors we need to use Arduino for interfacing.

b. *Wild life surveillance*

Many wild life species are going to extinct now a days due to radiation, hunters etc. this can be prevented by tracking and surveillance of wild life animals.

XVI. Result

After configuring all the parts, assembling as required, configuring Software and synchronizing the seeding system finally we obtained Agriculture robot which is shown below figure 9.2 it has performed the task of seeding well, As we concluded some limitations of this Agriculture robot those are happened in the work field. We need to test the Acceleration Calibration every time when we change the ground surface area. As per theoretical calculations it was supported to lift 2.64 kg but in practical it was lifted up to 1kg only. Aerial Practical values of Quadcopter are shown below:

Roll(Aileron)	Pitch(Elevator)	Yaw(Rudder)
P Gain: 35	35	50
P Limit: 100	100	20
I Gain: 30	30	50
I Limit: 20	20	11

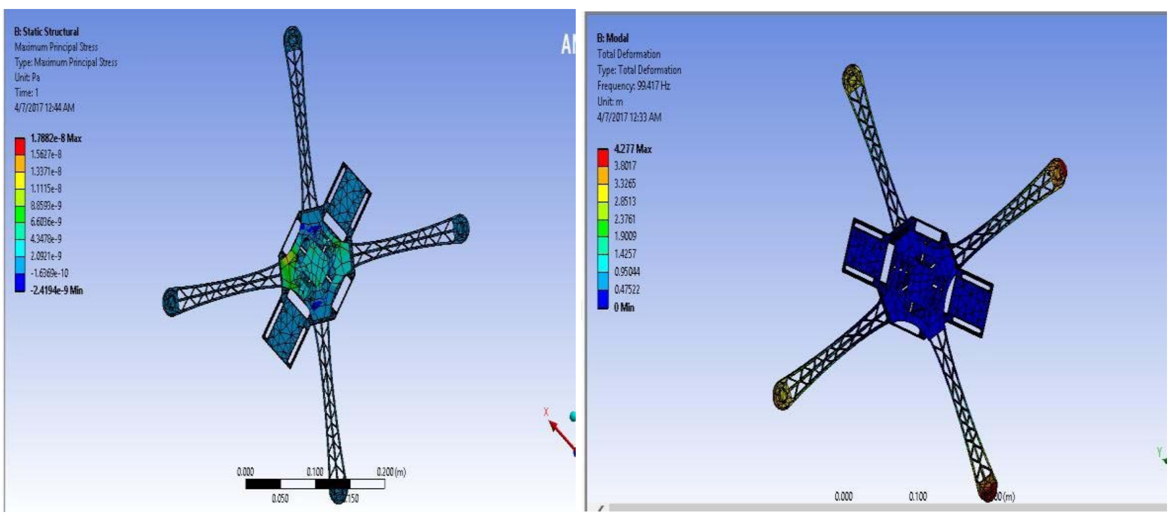

Figure 9.1: Analysis of Agriculture Robot

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Figure 9.2: Working of Agriculture Robot

XVII. Conclusion

In this project we have designed an AGRICULTURE ROBOT which is an architecture based on unmanned aerial vehicle(UAVs) and a Seeding System that can be employed to implement a control loop for agricultural applications where AGRICULTURE ROBOT is responsible for seed sowing. Here by we can reduce the human efforts not much but some amount. This will be helpful in performing the seeding task done in agricultural fields in less time. This will reduce the labour cost also and perform the work very accurate. This is completely operated by the radio transmitter and receiver with in the range of signal. If we are getting far away within the signal range then the AGRICULTURE ROBOT will not work properly.

This system may be further developed in many ways, by replacing the seeding system with other equipment's or systems like if cutter is placed then it will be used for cutting crops, if sprayer module is attached to drone then it will be used as pesticide spraying drone, and also if provided with high equipment's and cost then it also performs scanning of plants, security causes, inspecting crop details with specified seeds, fertilizers, pesticides as per soil condition suggested from scientists of agriculture on crops. The process of application is controlled by means of the feedback from the wireless sensors network developed aground level on the crop field.

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