Design and Development of Agro-Drone

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Abstract*- The main aim of this project work is to design Agriculture Drone for Spraying Pesticides. In this project, an architecture based on unmanned aerial vehicles (UAVs) is described. The use of pesticides in agriculture is essential to maintain the quality of large-scale production. It is essential to enhance the effectiveness and efficiency of agribusiness by supplanting workers with insightful machines like robots utilizing most recent advances. The undertaking proposes another methodology to supplant people in different rural tasks like discovery of essence of bugs, splashing of pesticides, showering of composts, and so forth. The developed system involves designing a prototype which uses simple cost effective equipment like microprocessor, various motors and terminal equipment which is an aid to the farmers in various crop field activities. This project is to mainly overcome the ill-effects of pesticides on human beings.*

Keywords- Agricultural Drone, Pesticides, Quality, ill-effects, supplanting workers.

I. INTRODUCTION

An unmanned aerial vehicle (UAV), commonly known as drone is an aircraft without a human pilot on board. Its flight is controlled either autonomously by computers in the vehicle or under the remote control of a pilot on the ground or in another vehicle. The average dispatch and recuperation strategy for an unmanned flying machine is by the capacity of a programmed framework or an outside administrator on the ground.

There are a wide variety of UAV shapes, sizes, configurations, and characteristics. Historically, UAVs were simple remotely piloted aircraft, but autonomous control is increasingly being employed.

Drones and fixed wing aircrafts are used in the agricultural pesticide spraying and monitoring. They can fill the tanks with the required pesticide and just fly the drone over the crops and drop the chemicals or water. Small time large area of land will be covered and thus this are used in the agricultural cases.

II. LITERATURE SURVEY

[1] The technique of spraying fertilizers and pesticides manually is now changing. It is the solution of problems such as scarcity of labours, human health issues which are faced by farmers while spraying chemicals on crops. **[2]** The vertical take-off and landing quad-copter is used to spray the pesticide. This paper describes the development of quad copter UAV and the sprayer module. The spraying time of pesticides is dependent on the quantity of pesticide to be sprayed. **[3]** The process of applying the chemicals is controlled by means of the feedback obtained from the wireless sensor network The pest management and vector control can be achieved by the integration of the spray system with the UAV results in an autonomous spray system. **[4]** The UAV is operated by manual flight plans and the Sprayer is manually triggered by RF controlled Nozzle. The vertical take-off and landing quad copter is used to spray the low volume pesticide in a small area. **[5]** This paper presents the design of a tilting rotor unmanned aerial vehicle (UAV), evaluation of flight loads based on the standard requirement, structural analysis to determine stress and sizing of the wing, and flight test of the UAV. **[6]** The developed system involves designing a prototype which uses simple cost effective equipment's like microprocessor, various motors and terminal equivalents which is an aid to the farmers in various crop field activities. **[7]** The algorithm to adapt the path runs in the UAV and its input is the feedback obtained from the wireless sensor network (WSN) deployed in the crop field. Moreover, we evaluate the impact of the number of communication messages between the UAV and the WSN. . Our aim is to introduce this technology to small/medium regional stakeholders in an effort to help them face their crop protection problems related to the effectiveness of common detection methods and to reduce their monitoring costs.
[8] Early in the design stage, a large number of samples are used in the collision and reliability test, which not only causes a waste of resources, but also puts a lot of manpower and resources. So the development cycle is quite lengthy. With the

continuing development of computer technology and scientific calculations, the introduction of the finite element method greatly shorten the development cycle frame. **[9]** Modern industrial agriculture is a very highly coupled system with dependencies on many uncontrollable components. This is in general why introducing a system that can facilitate early detection early response is a good idea. The process of spraying the pesticides using UAVs is controlled by means of a remote. The information is fed through remote which controls the functioning of valve to prevent the loss of pesticides. **[10]** In this paper we have described an architecture based on unmanned aerial vehicles (UAVs) that can be employed to implement a control loop for agricultural applications where UAVs are responsible for spraying chemicals on crops. The process of applying the chemicals is controlled by means of remote control.

III. THEORETICAL ANALYSIS OF DIFFERENT FACTORS RELATED TO DRONE

Table: Variation of flight time with different payload capacity

PAYLOAD (in grams)	ALL UP WEIGHT (in grams)	TOTAL WEIGHT (in grams)	THRUST RATIO	FLIGHT TIME (in min)	MOTOR SPECS	BATTERY CAPACITY (in mAh)
1486	3280	4766	1.7:1	9.3	1125KV-68mm	5500
2029	3471	5500	1.8:1	8.2	1200KV-68mm	10000
3162	3346	6508	2.2:1	8.5	1400KV-68mm	10000
4011	3409	7420	2.5:1	8.3	1500KV	10000
5178	3401	8579	2.9:1	8.0	1780KV	10000
5910	3216	9126	3.3:1	8.7	1900KV	10000
7094	3953	11047	3.3:1	7.1	2100KV	10000
8237	3276	11513	4.1:1	9.2	2100KV	10000
8935	3973	12908	3.8:1	6.8	2680KV	10000
10153	4283	14436	3.9:1	6.2	2800KV	10000

Mathematical Formulae Used In Calculation

<u>Quad copter flight times = (Battery Capacity * Battery Discharge /Average Amp Draw)*60</u>

⇨ For 1000 gram payload,
Battery capacity : 5500mAh or 5.5 Ah
Battery discharge : 80% => 0.8*5.5 = 4.4 Ah
Average Amp draw : 156.25 Amps
Quad copter flight time =><u>9.3 min.</u>

As it is the calculation is followed till 10 kg payload.

<u>Thrust- weight ratio= total thrust of all motors/ total weight of model</u>

⇨ For 1000 gram payload,
Total thrust of all motors : 8 kg
Total weight of model : (3280+1000) grams
Thrust-weight ratio : <u>1.86:1.</u>
As it is the calculation is followed till 10 kg payload.

<u>Payload Capacity = (Motor thrust * Number of motors * Hover Throttle %) –The weight of the model itself.</u>

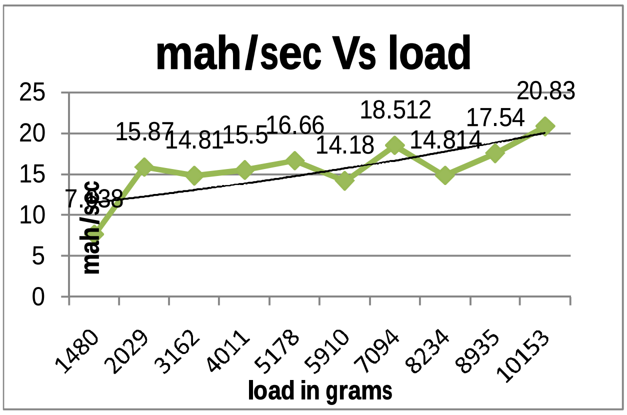
⇨ Motor thrust : 2000 grams
Number of motors used : 04
Hover throttle percent : 50%
Weight of the model : 3000 grams
Payload capacity : <u>1000 grams</u>

As it is the calculation is followed according to the motor selection.

IV. GRAPHICAL ANALYSIS

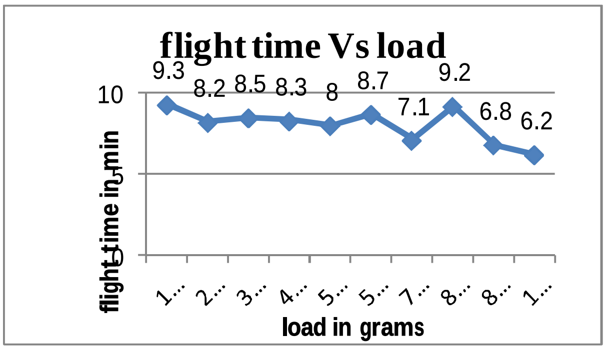
Graph 1: mah/sec Vs Load

The below plot depicts the variation between milliamps/sec Vs load in grams. As load increases the rate of power consumption gradually increases. In this graph 1st point is the minimum value and the value goes on increasing till the last point. The straight line indicates the average increase in the graph for different values of load as shown.



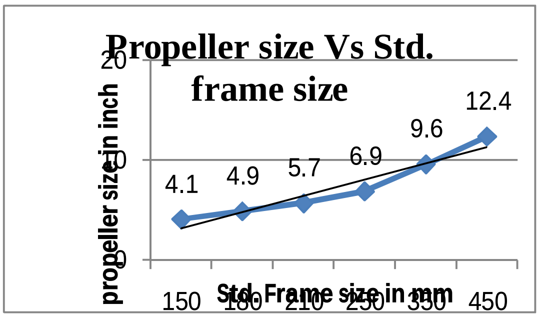
Graph 2: Flight time vs load

The belowplot depicts the variation between flight time Vs load in grams. It shows the decrease in flight time as the load increases. The flight time is highest initially and as the load increases the flight time decreases for different motor specifications. The overall plot is decreasing for increasing loads.



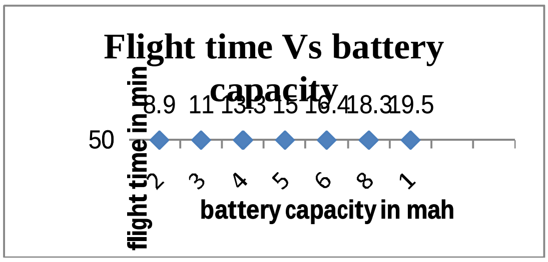
Graph 3: Propeller size vs Frame size

The belowplot depicts the variation between propeller size Vs standard Frame size. In the Fig 1.8 shows the size of propeller is increased for different frame sizes.



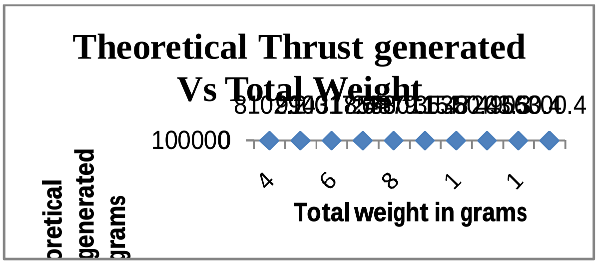
Graph 4: Flight time vs Battery capacity

The above plot depicts the variation between flight time Vs battery capacity. As the power of battery increases the flight time increases. The above plot is done for motor with same specification throughout.



Graph 5: Theoretical thrust generated vs Total weight

The above plot depicts the variation between Theoretical thrust generated Vs Total weights. Total weight indicates both drive weight and payload weight. The thrust to total weight ratio should be more than or equal to 2:1. As the weight increases the specific thrust ratio increases and also the thrust generated. The plot shows the average increase in the thrust generated.

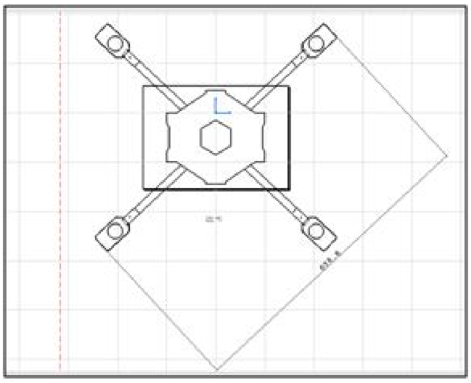


V .DESIGN OF QUADCOPTER FRAME

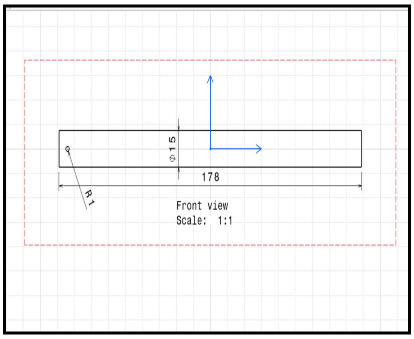
Design Specifications and Drafting of the quad copter frame

These are the design specification required to build a Quad copter,

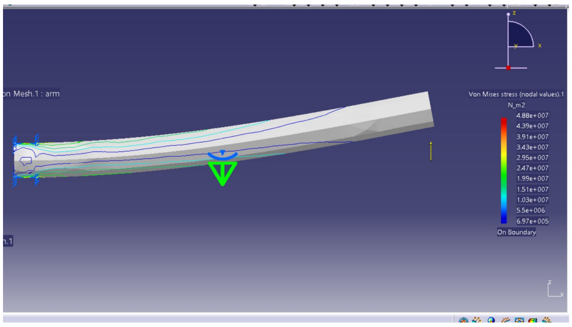
Frame size	: 450 X 450 mm
Motor – Motor distance	: 600 mm
Arm diameter	: 16 mm
Centre body dimension	:190 X 200 X 2 mm
Propeller size	: 10 X 4.5”



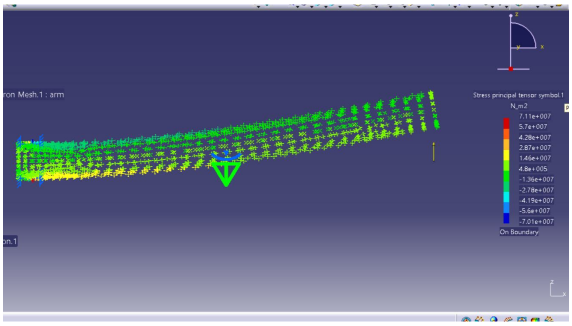
VON MISSES STRESS ANALYSIS



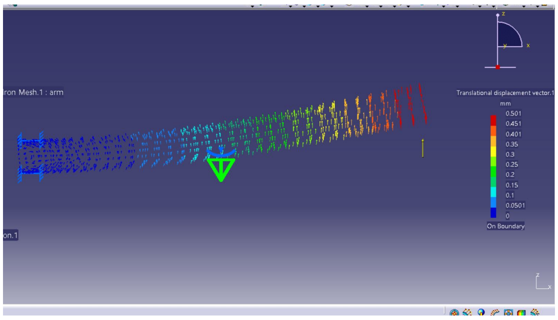
PRINCIPAL STRESS

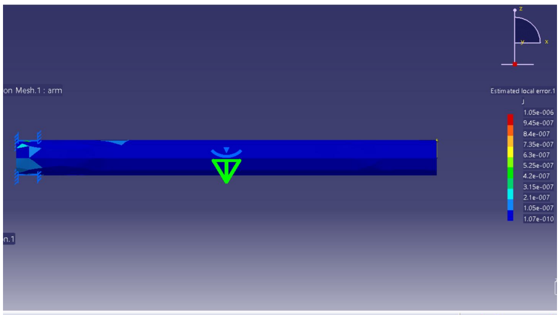


TRANSLATIONAL DISPLACEMENT

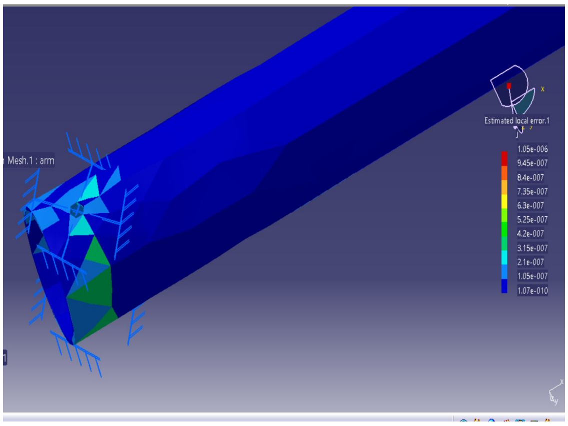


ESTIMATED LOCAL ERROR





ESTIMATED LOCAL ERROR (AT FIXED JOINT DEEP SECTION)



QUADCOPTER AND ITS HARDWARE COMPONENTS USED

Quadcopter frame

Brushless 3pole motors

5500Mah Battery

Electronic speed controller (ESC)

AGRICULTURAL APPLICATION

Unmanned aerial vehicles (UAV's) are operated remotely either by telemetry, where the operator maintains visual contact with the aircraft or autonomously along pre-programmed paths using GPS and inertial guidance. The initial uses in agriculture have been for remote sensing, with an emphasis on visual inspection of crop or field conditions and for tracking assets such as machinery, workers or product. UAV technology has utility in agriculture, forestry and vector control for not only observation and sensing but also for delivery of payloads, including application of agrochemicals. The use of yield data sources, for example, fertilizers and pesticides by UAV presents a building configuration challenge where the payload and power requests from a splashing or granular instrument are essentially more noteworthy than those of low-mass, low-control cameras or sensors for examination. Increases in the payload mass that can be carried on-board and dispensed leads to increased flight endurance and improved economic return.

Equipment's used for spraying mechanism

The main equipment used for the spraying mechanism in drone are as follows,

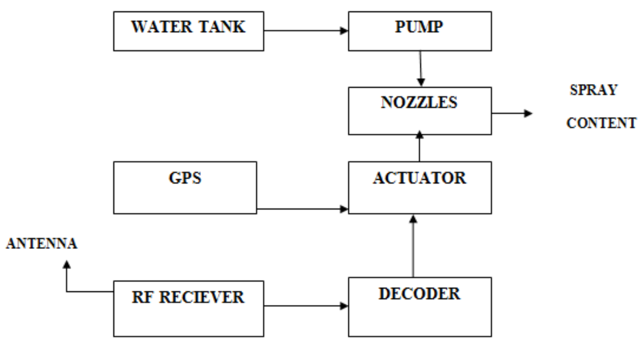
- 1way Nozzle
- Water pump
- Pump governor
- Water pipes
- Water tank.
- Mini arduino board

Working procedure

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 segments, showering module and controller. Showering module contains the splashing content i.e., pesticide or manure and the controller area used to initiate the nozzle of sprayer. The order is gotten from remote controller which is enacted physically. Tank contains the synthetic substance which will shower on crops that might be a pesticide or manure. The Nozzle of the sprayer module will be activated by GPS device. This GPS module having the preloaded GPS coordinated.

EQUIPMENT SETUP OF APPLICATION (BLOCK DIAGRAM)



V. CONCLUSION

Agricultural drone have the potential to improve the yield crops and also can help the farmers to transform the agriculture industry. The agricultural sector can benefit significantly from implementation of unmanned aerial vehicles with the potential to improve the soil and plant knowledge, efficiency of input, and economical and environmental sustainability. Nonetheless, their viable execution relies on some required basic perspectives that must be considered, including the setup, mass, payload, flight range and expenses. Cost adequacy can be demonstrated in situations where UAV can be connected to cover extensive land territories; never the less, changes stay essential with respect to battery term, and therefore, payload and flight self-rule.

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