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Design, Development & Optimization of a Quad-Copter for Agricultural Applications

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Abstract- *Currently, Agricultural field facing some trouble: - the lack of human toil. There are some reasons like it requires hard oeuvre which causes tiredness and some field workers are migrating from the farm to other sphere in the industriousness which offers them more stable and more profitable jobs. In this scenario, it becomes necessary to introduce and develop agricultural automation and detection technology for increase agricultural productiveness. In this system we introduce Quad-copter [QC] which is low weight and low cost. It is also known as UAV i.e. Unmanned flying Vehicle. This framework lessen the issue identified with the farming field & make it precision agriculture with furthermore enhance the rural profitability. This framework lessens the medical issues which are created by manual splashing.*

Keywords: *quad-copter, UAV i.e. Unmanned flying Vehicle, lithe mobility, autonomous flight, precision agriculture.*

1. INTRODUCTION

India and other creating nations are confronting numerous issues in agribusiness field like lack of work, medical problems. According to World Wellbeing Organization study, there are 3 million or more instances of pesticide harming in every year [1]. Asthma, Allergies and Hypersensitivity are the prospect impact on human wellbeing on presentation to pesticides. Youngsters and new conceived infants are at awesome hazard to presentation of pesticides since they are not having solid safe framework. The coupling between field specialists and robots ought to be done in such a way, to the point that people ought to feel great within the sight of robots. HRI framework is presented to face issues, for example, directions, wellbeing and comfort. Adaptable robotization is engaged in this work [2].

This paper presents a quad copter outline which is utilized for pesticide showering in horticulture field .This framework lessens the issue identified with the agrarian field and furthermore enhances the farming efficiency.

2. MECHANICAL DESIGN

2.1 Design Methodology of arm

Design of Quad Copter Arm (Static load consideration)
Material used Aluminum 6061-T6
- Density = 2712 kg/m^3
- Modulus of Elasticity = 68947.57 MPa
- Poisson's Ratio = 0.33
- Yield stress = 275.79 MPa
- Ultimate Stress = 310.264 MPa

Considering Theory of Failure: [3]
- Factor of safety (FOS) = Yield point stress/Design stress
- Let FOS = 10Thus Design Stress= Yield point stress/FOS
- Design Stress = 275.79/10 = 27.579 MPa

The composed arms have capacity to support bigger burdens. Triangulated configuration is for longer existence with high component of wellbeing. Material utilized is lightweight aluminum body .Designed for simple arrangements for all mountings. (fig.1)

Fig -1: UAV arm design

2.2 Propeller

On each of the brushless engines there are mounted a propeller. The 4 propellers are really not indistinguishable. In the event that you observe the photo above you will see that the front and the back

propellers are tilted to one side, while the left and right propellers are tilted to one side (fig.2). This purpose behind this is the engine torque of and the law of material science will make the Quad Copter turn around itself if every one of the propellers were pivoting a similar route, with no possibility of balancing out it. By making the propeller sets turn toward every path, additionally having inverse tilting, every one of them will give lifting pushed without turning in a similar heading. This makes it feasible for the Quad Copter to settle the yaw turn, which is simply the revolution. (fig.3)

Fig -2: Unique full propeller design

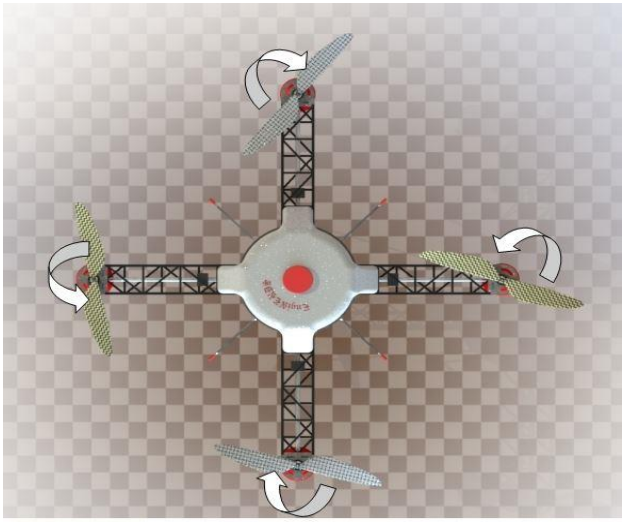

Fig -3: Propeller motion in direction

- 1045 – 10″ diameter and 4.5″ pitch – this is the most popular one, good for mid-sized quads
- 0845 – 8″ diameter and 4.5″ pitch – regularly used in smaller quads
- 1245 – 12″ diameter and 4.5″ pitch – used for larger quads which require lot of thrust

When using high RPM motors should go for the smaller or mid-sized propellers & larger propellers give more thrust per revolution from the motor.[4]

2.3 Pesticide Sprayer and Cover

It is connected with propeller shaft so no need of additional engine for splashing .Due to exceptional outline it is effortlessly removable, washable. Material utilized is plastic, thus cost effective and light weight it splashes productively every which way & covers containing additional fold towards camera side to maintain a strategic distance from shower on camera and other electrical segments and this cover is dashed with engine.[6]

Due to unique design of the sprayer & piping system it enhance flow of pesticide due to gravity which itself reduces power consumption.

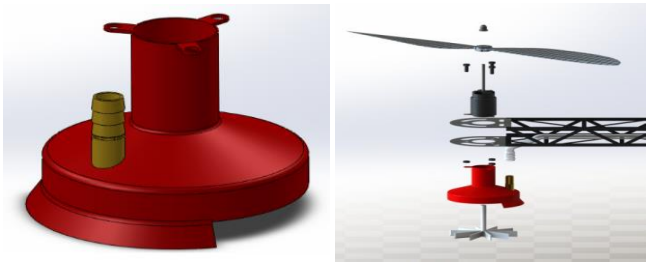

Fig -4: Design & Exploded view of Pesticide Sprayer

2.4 Pesticide container

Because of one of a kind plan it has effectively removable system and washable with surmised volume of 1.5 lit to 3 lit. Material utilized is lightweight plastic body. Slant is given to base of tank to upgrade gravity stream.

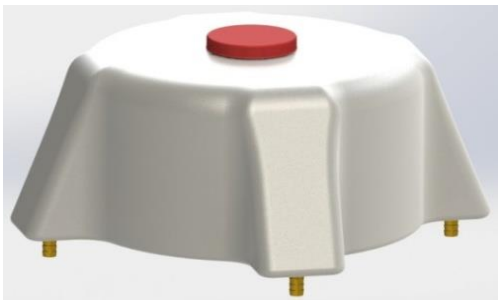

Fig -5: Design of Pesticide container

2.5 Piping system

The 6mm ID transparent removable rubber pipes fitted with tight hose clamps at ends along with flow control electronic valves.

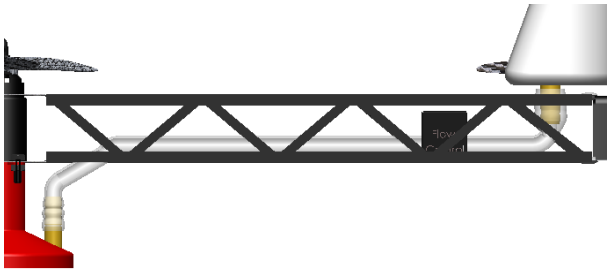

Fig -6: Design of piping system

2.6 Mounting plates

Aluminum alloys sheet metals with provisions for mounting of various components because it is rigid enough to sustain all forces.

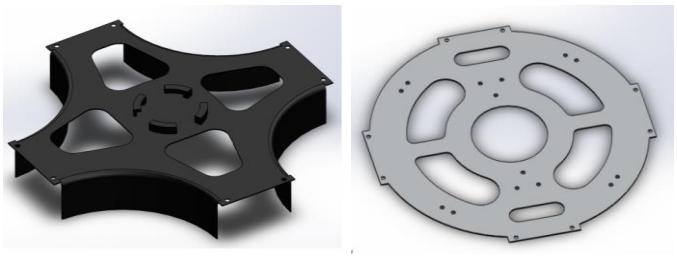

Fig -7: Design of mounting plates

2.7 Stand

Material used is mainly stainless steel. The tubular stands riveted to base mounting plate with enough height to operate in farms and nurseries with rubber bushing at base for safe landing.

Fig- 8: Design of Stand

2.8 Brushless Motor

As the name infers, BLDC (Brushless DC) engines don't utilize brushes for compensation. They are electronically commutated and the focal points are: Better speed versus torque qualities, High proficiency with Noiseless operation and rapid range with longer life. There is no starting and a great deal less electrical noise. [5]

Specifications:

KV (rpm/v): 1300; Max Power: 190W
Max Thrust: 920 grams
Weight: 53 grams
Shaft Diameter: 3.175mm
Shaft Length: 45mm
Recommended Propeller for battery: 12×4.5 for 2S battery; 10×4.5 for 4S battery
Battery: 2S-4S Li-Po
ESC (A): 30A

3. EXPLODED VIEW OF THE QUAD COPTER

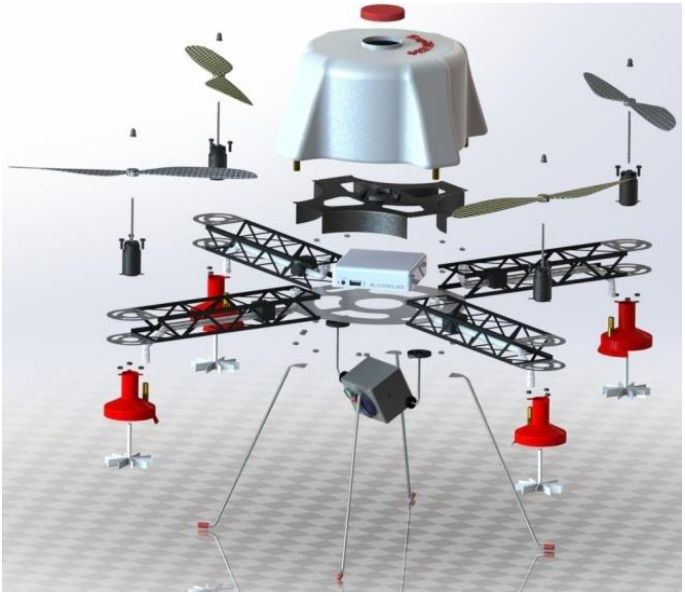

Fig -9: The all parts assembly of the quad copter

3.1 RENDERINGS AND MOTION

Fig -10: The quad copter overview

4. OPTIMIZATION OF TIME OF SPRAYING WEIGHT OF QUAD COPTER &NOZZLE DIAMETER

As the time and the heaviness of the quad copter is the fundamental factor which influences the cost and the process duration and in addition effectiveness of the framework, so improvement of these elements is essential which considered making the UAV framework operation quick and temperate.

Following table 1 gives the diagram of the two noteworthy parameters like spout distance across and weight of the quad copter with its base and most extreme essentially conceivable esteems alongside numerically ascertained standard deviation of the chose parameters.

Table 1: Input parameters which considered for optimization

Factor	A	B
Name	Nozzle Diameter size	Weight of quad copter
Units	mm	grams
Type	Numeric	Numeric
Minimum	0.343146	741.117
Maximum	11.6569	2508.88
Values	1.000=10	1.000=2250
Mean	6	1625
Std. Dev.	3.26599	510.31

Table 2 gives the connection of the reliance estimation of the chose parameters and the yield factors like speed and time for splashing, which is additionally streamlined by considering the continuous condition.

Following is the required estimations of the different parameters under which framework works great and gives most extreme effectiveness

Actual Factor

- A: Nozzle Diameter size = 2.40516 mm
- B: Weight of quad copter = 1000 grams
- Desirability = 0.974348
- Velocity of quad copter (m/s) =0.623374
- Time of spraying (sec) = 13.975

Table 2: Output calculated parameters which considered for optimization

Response	R1	R2
Name	Velocity of Quad copter	Time for spraying
Units	m/s	Sec
Analysis	Polynomial	Polynomial
Minimum	0.1	4.45
Maximum	0.7	23.5
Mean	0.442308	12.0731
Std. Dev.	0.151171	5.72409
Ratio	7	5.2809

Following diagram gives the connection between the parameters which acclimates the ideal purpose of the framework as said above in real factors.

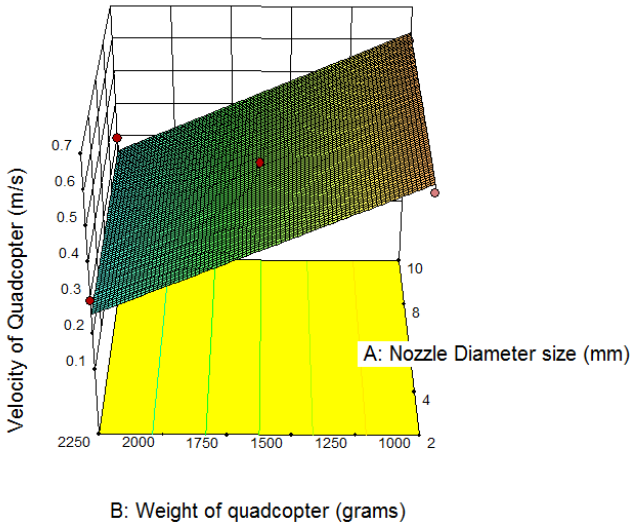

Fig -11: Relation between velocities, weight of quad copter along with nozzle diameter size

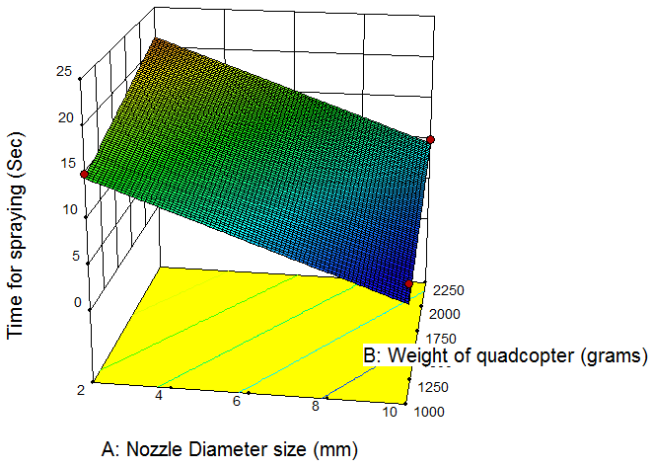

Fig -12: Relation between times of spraying, weight of quad copter along with nozzle diameter size

5. CONCLUSION

To some degree, the principle objective in the improvement of exactness cultivating is to supplant the customary rural practices. This paper presented the essential general standards utilized as a part of outlining a quad copter and upgrading the heaviness of the framework, splashing spout distance across, direct speed of framework and required time by the UAV for reconnaissance of ranch.

Subsequently the pesticide showering quad copter can productively splashes on ranches, uneven regions and

nurseries. Mechanization was accomplished at fullest for the reason. Because of Unique design it became safer, cheaper, efficient and useful smart product, for villages.

The fundamental concentration region of utilizing this UAV is least utilization of pesticides because of target activity system and it can clean at any part and at any stature. No human interface so no mix-up. Utilizing heat sensors, pest can be identified at any phase of their development.

This paper additionally accommodating for tackling the issues like lack of work, medical problems which are confronted by farmers during pesticide spraying

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