DESIGN and FABRICATION of AGRICULTURAL SPRAY DRONE

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Abstract- *The constant development of agricultural drone is variant. The use of Unmanned Ariel vehicle was one the most reliable approach to agriculture and various other field of work. Various kinds of drone are introduced in the market serving various purposes. The famous amongst those are Quad-Copter, Octo-Copter etc. The most significant objective of the making of this drone was the cost effective purpose before serving the mankind. The Quad-Copter with an Radio Telemetry, GPS Module, Spray Mechanism and is capable of lifting up to 10kgs of weight.*

Keywords- Quad-Copter, Radio Telemetry, GPS Module, Spray Mechanism, Unmanned Ariel Vehicle.

I. INTRODUCTION

Automations have been around for a considerable length of time, and they are utilized for various purposes and is of assistance in various events. Nonetheless, these gadgets have turned out to be more famous as of late and their application increments quickly in different fields. The quad-copter, hexa-copter, octo-copter, single rotor helicopters are the famous creation with regards to taking about automations nowadays. When discussing an automaton as an electric gadget, we considering rocket or a remote-controlled pilotless flying machine. A standout amongst the most utilized definitions for ramble is: "An unmanned air vehicle that can explore self-hoveringly, without human control or past the viewable pathway". Another every now and again utilized definition is: "Automaton is any unmanned flying machine or ship that is guided remotely". Presumably, rambles are among the most developed gadgets in the present flight, hardware and apply autonomy alike. In the accompanying content, automaton will be clarified quickly, their arrangements, their applications and the fate of automatons. We will likewise discuss the best automatons made for 2017 and past.

The Agricultural Drone is the approach of making the use of pesticides spray mechanism. A better way of getting the farmers a rest to their daily work of making our lives easier. 64.6% of land Karnataka holds for agricultural purpose, 71% is involved in agricultural field work[6]. The agricultural Drone that we have made is a quad-copter with a spray mechanism for the springer of pesticides in the fields. Our Tactic is to make the drone not just easy to work with but here we have made use of the radio telemetry. The purpose of this is to set the field mark with directions of springer on the RC transmitters and the radio telemetry will come to the initial start after the completion of the work.

Indian farming required generation and assurance materials to accomplish high profitability. Farming compost and synthetic habitually expected to slaughter bugs and development of products. The WHO (World Health Organization) evaluates there are in excess of 1 million pesticide cases in consistently. In that in excess of one lakh passing's in every year, particularly in creating nations because of the pesticides showered by individual. The pesticide influences the sensory system of people and furthermore prompts issue in body. A remote controlled UAV (Unmanned Aerial Vehicle) is utilized to splash the Pesticide and additionally compost to stay away from the people from pesticide harm. The UAV is worked by manual flight designs and the Sprayer is physically activated by RF controlled Nozzle. The vertical take-off and landing quadcopter is utilized to splash the low volume pesticide in a little territory. This undertaking portrays the advancement of quadcopter UAV and the sprayer module. And furthermore talks about the combination of sprayer module to quad copter framework. This model is utilized to splash the pesticide substance to the zones that can't without much of a stretch open by people. The Universal Sprayer framework is utilized to splash the fluid and in addition strong substance which are finished by the all inclusive nozzle. Multispectral camera is utilized to catch the remote detecting pictures which are utilized to distinguish the green fields and additionally the edges of yield territory. Add up to payload lift-off weight of quad copter is 8 kg. Remote detecting pictures are dissected by QGIS programming[1].

In this task, an economically fabricated UAS-mounted splash framework was sent in high-esteem forte harvests in California. The UAS utilized as a part of this task was an unmanned elevated vehicle (UAV) and a related ground control station that gave a way to remote guiding of the flying machine. The flying machine was an oil fuelled helicopter (RMAX, Yamaha Motor Co. USA, Cypress, CA USA) initially produced for splashing of rice fields in Asia. In

this test, the essential test zones for shower testimony and execution evaluation incorporated a 0.61 ha square of Cabernet Sauvignon wine grapes situated at the University of California Oakville Field Station in Napa County, CA USA. The square comprised of 42 columns, each 61 m long with a line dispersing of 2.4 m. Contingent upon the splash technique conveyed, particularly, the swath width utilized and the flight design flown, the UAS shower application could accomplish 2.0 to 4.5 ha/h work rates while applying volume rates of 14.0 to 39.0 L/ha. Shower affidavit on the grape foliage expanded with connected volume rate. In correlations with ground-based splashes at 935 L/hr., affidavit in the grape covering from the UAS at 47 L/ha was comparable[2].

This article gives nitty gritty comprehension on agribusiness ramble under intelligent headings and subheadings. Article features the mechanical parts of conspicuously utilized horticultural automatons alongside the points of interest and weaknesses. This article will help the peruser in deciphering the future extent of utilizing rambles in the agriculture sector[3].

The utilization of pesticides and composts in rural territories is of prime significance for edit yields. The utilization of flying machines is ending up progressively regular in doing this assignment for the most part due to its speed and viability in the showering activity. Be that as it may, a few components may diminish the yield, or even reason harm. Climatic condition, for example, the force and bearing of the breeze while splashing add promote multifaceted nature to the control issue. In this paper, we portray an engineering in light of unmanned flying vehicles(UAVs) which can be utilized to actualize a control circle for agrarian applications where UAVs are in charge of showering chemicals on crops. The way toward applying the chemicals is controlled by methods for the input got from the remote sensor organize (WSN) conveyed on the yield field. The point of this arrangement is to help short deferrals in the control circle with the goal that the showering UAV can process the data from the sensors. We assess a calculation to alter the UAV course under alters in wind force and course. In addition, we assess the effect of the quantity of correspondence messages between the UAV and limit the misuse of pesticides[4].

This examination centres around the usage and showing of the Real Time Path Planner (RTPP). It is an AI direction framework that was produced for an operational DoD unmanned aeronautical target control framework. The RTPP is tried utilizing the 6-DOF target test system of Drone Formation Control System (DFCS). UAV flight directions created by this framework experience testing in a DoD pilot training program. An MQM-107D mimicked ramble is utilized for the testing. The segment size of the territory outline shifted inside the investigation to acquire an ideal parcel measure. This examination shows that the RTPP produces sheltered and flexibility courses for the MQM-107D. Results are affirmed by time plots of key flight parameters recorded amid the 6-DOF UAV re-enactment runs. The time plots demonstrate that the objective did not have any trouble flying the PC produced design. It additionally demonstrates that the objective flew over be near landscape as anticipated by the RTPP to achieve its goal. This investigation exhibits the inventive advantages and usefulness added by Intelligent Systems hypothesis to the continuous way arranging and route undertaking by means of the DFCS framework. The RTPP functions as outlined, creating protected and flyable flight designs for the automaton[5].

II. COMPONENTS AND THEIR SPECIFICATIONS

1. Mechanical Components

Components	Specifications	Quantity
Base plate	Aluminium 6061	1
Arms	Aluminium 6061	4
Propellers	12"/4.5"	4
Spray Nozzle	Misting Nozzle	1
Pump	Diaphragm	1

2. Electrical Components

Components	Specifications	Quantity
Electronic Speed Controller(ESC)	40Amps, 2-6 cells	4
Flight Controller	Arduino AMP 2.8	1
GPS Module	UBLOX	1
Transmitter Module	2.4 GHz	1
Receiver Module	2.4GHz	1
LIPO Batteries	6s, 10000MAh	1
Lithium Ion battery	3.74v	4
Brushless Motors	5010,750Kv	4 4

III. DESIGN ANALYSIS

For the base plate and the efficient load carried by it.

Materials

Material	Aluminium
Young's modulus	7e+010N_m2
Poisson's ratio	0.346
Density	2710kg_m3
Coefficient of thermal expansion	2.36e-005_Kdeg
Yield strength	9.5e+007N_m2

Static Case Solution

Name: Static Case Solution
Restraint: Restraints.1
Load: Loads.1
Strain Energy : 1.030e-002 J
Tightening analysis
(Solid to solid tightening join)

Contact Element	Contact Force N	Initial Clearance mm	Final Clearance mm
31426	6.3310e+001	-2.3443e-003	0.0000e+000
31427	7.5591e+001	-5.9754e-003	0.0000e+000
31428	6.9479e+001	-3.5373e-004	0.0000e+000
31429	7.6313e+001	-2.4000e-003	0.0000e+000
31430	7.6361e+001	-2.3487e-003	0.0000e+000
31431	7.5662e+001	-2.7932e-003	0.0000e+000
31432	5.2932e+00	-7.7391e-	0.0000e+00
31433	6.0819e+001	-2.9183e-004	0.0000e+000
31434	1.4449e+002	-7.3393e-004	0.0000e+000
31435	6.3862e+001	-2.3384e-003	0.0000e+000
31436	7.5376e+001	-5.6451e-003	0.0000e+000
31437	6.1304e+001	-2.3373e-003	0.0000e+000
31438	7.5410e+001	-6.0060e-003	0.0000e+000
31439	1.5167e+002	-4.8872e-003	0.0000e+000

Equilibrium

Components	Applied Forces	Reactions	Residual	Relative Magnitude Error
Fx (N)	4.4764e-014	-4.2759e-010	-4.2755e-010	6.6787e-013
Fy (N)	2.3598e-014	1.3845e-009	1.3846e-009	2.1628e-012
Fz (N)	-1.5000e+002	1.5000e+002	6.1369e-009	9.5863e-012
Mx (Nxm)	4.9420e-009	-5.0911e-009	-1.4911e-010	5.7105e-013
My (Nxm)	1.2342e-008	-1.0949e-008	1.3934e-009	5.3364e-012
Mz (Nxm)	-9.2862e-017	-2.0708e-010	-2.0708e-010	7.9305e-013

Static Case Solution : Computation summary
STRUCTURE Computation

Number of nodes	: 11180
Number of elements	: 32222

Number of D.O.F.	: 33540
Number of Contact relations	: 14
Number of coefficients	: 101
Number of Kinematic relations	: 811
Number of coefficients	: 3312

Linear tetrahedron	: 31425
Solid to solid tightening join	: 14
Slider join	: 783

RESTRAINT Computation

Name: Restraints.1
Number of S.P.C : 432

LOAD Computation

Name: Loads.1
Applied load resultant :

Fx	= 4 . 476e-014	N
Fy	= 2 . 360e-014	N
Fz	= -1 . 500e+002	N
Mx	= 4 . 942e-009	Nxm
My	= 1 . 234e-008	Nxm
Mz	= -9 . 286e-017	Nxm

STIFFNESS Computation

Number of lines	: 33540
Number of coefficients	: 551919
Number of blocks	: 2
Maximum number of coefficients per bloc	: 499989
Total matrix size	: 6 . 44 Mb

SINGULARITY Computation

Restraint: Restraints.1

Number of local singularities	: 0
Number of singularities in translation	: 0
Number of singularities in rotation	: 0
Generated constraint type	: MPC

CONSTRAINT Computation

Restraint: Restraints.1

Number of constraints	: 1225
Number of coefficients	: 0
Number of factorized constraints	: 1225
Number of coefficients	: 2552
Number of deferred constraints	: 0

FACTORIZED Computation

Method	: SPARSE
Number of factorized degrees	: 32315
Number of supernodes	: 6407
Number of overhead indices	: 252853
Number of coefficients	: 2674984
Maximum front width	: 272
Maximum front size	: 37128
Size of the factorized matrix (Mb)	: 20 . 4085
Number of blocks	: 3
Number of Mflops for factorization	: 3 . 663e+002
Number of Mflops for solve	: 1 . 086e+001
Minimum relative pivot	: 3 . 658e-005

Minimum and maximum pivot

Value	Dof	Node	x (mm)	y (mm)	z (mm)
4.2321e+005	Ty	11175	1.3778e+002	3.2463e+002	-9.2414e+001
1.6246e+010	Ty	7551	1.6292e+002	-7.9825e+001	-7.5198e+001

Minimum pivot

Value	Dof	Node	x (mm)	y (mm)	z (mm)
6.2191e+005	Ty	11162	6.5742e+001	1.5089e+002	-9.2414e+001

7.4167e+005	Tz	11180	1.6315e+002	3.8213e+002	-9.2374e+001
1.1514e+006	Tz	11120	5.8034e+001	1.3752e+002	-9.1824e+001
1.2486e+006	Ty	10713	7.1339e+001	1.7214e+002	-6.7924e+001
1.9264e+006	Ty	10318	8.0805e+001	1.6242e+002	-8.1338e+001
1.9526e+006	Ty	11180	1.6315e+002	3.8213e+002	-9.2374e+001
2.0820e+006	Tz	11175	1.3778e+002	3.2463e+002	-9.2414e+001
2.2942e+006	Ty	11168	9.9271e+001	2.3184e+002	-9.2414e+001
2.5592e+006	Tx	11180	1.6315e+002	3.8213e+002	-9.2374e+001

Translational pivot distribution

Value	Percentage
10.E5 --> 10.E6	9.2836e-003
10.E6 --> 10.E7	5.5702e-002
10.E7 --> 10.E8	3.0574e+000
10.E8 --> 10.E9	6.6121e+001
10.E9 --> 10.E10	3.0723e+001
10.E10 --> 10.E11	3.4040e-002

DIRECT METHOD Computation

Static Case Solution.1
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Load: Loads.1
Strain Energy : 1.030e-002 J
Tightening analysis
(Solid to solid tightening join)

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31436	7.5376e+001	-5.6451e-003	0.0000e+000
31437	6.1304e+001	-2.3373e-003	0.0000e+000
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Mz (Nxm)	-9.2862e-017	-2.0708e-010	-2.0708e-010	7.9305e-013

Static Case Solution - Von Mises stress (nodal values)

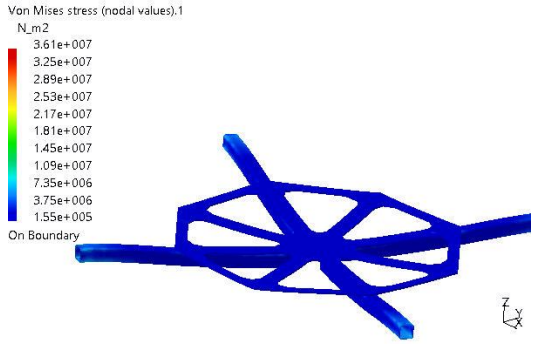

Figure 1
1Delements:: Components: : All
3Delements:: Components: : All
On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution - Translational displacement vector

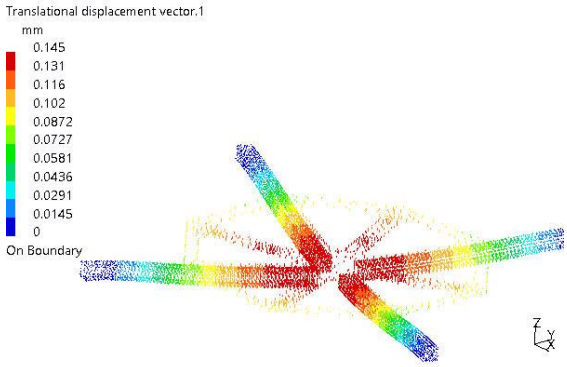

Figure 2

1Delements:: Components: : All
3Delements:: Components: : All
On deformed mesh ---- On boundary ---- Over all the model

Static Case Solution - Deformed mesh

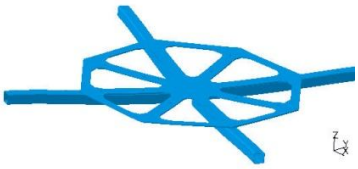

Figure 3
On deformed mesh ---- On boundary ---- Over all the mode

IV. METHODOLOGY

Bolster plate outline

For the structure we are utilizing aluminium plates of modern review and check 16. The measurements of the help plates before machining are 0.6*0.6m. CNC processing task is performed in the plates to get the coveted shape and evacuate pointless material in such a path, to the point that the aggregate weight of the plates is kept least without trading off on the quality of the structure.

Drone arms:

For the arms of the automaton where the engines are settled we are utilizing rectangular aluminium containers of divider thickness 3mm.

Assembly of automation without engines:

The whole structure is assembled which is the aluminium tubes and the help plates. This will be held together with the utilization of clasp of appropriate quality and measurements.

The electrical components:

The flight controller is placed on the centre of the front face of the base plate along with the RC Receivers. The Flight Controllers and the RC receivers is wired in number of series with the ESC placed in each arm. The ESC are connected to the motors which is responsible to supply power to the motors to run.

The spray mechanism:

The propellers are fitted in each of the motors and then the LIPO battery is installed at the bottoms of the base plate. The GPS Module is close-fitting on the top of the base plate. The bottom base of plate is held on the firm stand where just below the battery goes, the spray mechanism along with the pump.

The Radio telemetry is also fitted along with the GPS Module to track and bring the drone back to its locations of start after completion of the work.

Figure 4: The Quad-copter drone.

Figure 5: The drone under operation.

V. CONCLUSION

With the presentation of such elective innovation for cultivating it would make the field of horticulture simpler, decrease wellbeing perils, increment profitability of the products and beneficial in the long run thus reassuring more individuals to get into this training. The prime intention of the venture is to carry new thoughts into the field of farming. With our outline the idea of utilizing a Drone idea made at a similarly bring down cost when contrasted with the current automatons (Frame), utilizing the automaton for farming application which to be particular is showering of pesticide which is controlled remotely. This idea can be utilized as a model for encourage improvements to be done with a specific end goal to make it more dependable, savvy and productive. Farming is a critical to manage human presence yet, this field is winding up less alluring for new individuals to get into and for the leaving ranchers likewise because of the real issues looked because of absence of work, medical problems and less gainfulness with the present market situations. With this UAV which we have composed the clients have an option for procedure of showering pesticides onto the products without being in genuine contact with the chemicals which would be exceptionally regular when utilized as a part of the manual techniques.

VI. ACKNOWLEDGMENT

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REFERENCES

[1] S. Meivel M.E, Dr. R. Maguteeswaran Ph.D, G. Srinivasan Ph.D, “Quad copter UAV Based Fertilizer and Pesticide Spraying System”,
[2] Journal of Engineering Sciences, Vol. no.1 issue no 1, February 2016,
[3] Durham K. Giles, Ryan C. Billing, “Deployment and Performance of a UAV for Crop Spraying” , a publication of AIDIC, VOL. 44, 2015
[4] MD. Alimuzzaman,“Agricultural Drone”.
[5] Y. Huang, W. C. Hoffmann, Y. Lan, W. Wu, B. K. Fritz, “Development of a spray system for an unmanned aerial vehicle platform”,Vol. 25(6)

[6] Y.A. Pederi, H.S. Cheporniuk, “Unmanned Aerial Vehicles and New Technological Methods of Monitoring and Crop Protection in Precision Agriculture” presented at 2015 ,IEEE
[7] https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle