PROJECT REPORT

DRONE FERTILIZER SPRAYER

Submitted in partial fulfilment of the requirement for award of

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BACHELOR OF SCIENCE

IN

AERONAUTICS (AVIONICS)

By

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BONAFIDE CERTIFICATE

This is to certify that the project report titled **DRONE FERTILIZER SPRAYER** is a bonafide record of work carried out by Mr. HARIOM KUMAR ARYA during the final semester from FEB 2021" to "MAY 2021 and under my guidance, in partial fulfilment of 20201

the requirements for the award of BACHELOR OF SCIENCE – in AERONAUTICS (AVOINICS)

DECLARATION

I, Mr. Hariom Kumar Arya hereby declared that this project report titled **DRONE FERTILIZER SPRAYER** submitted in partial fulfilment of the requirement For the award of **"BACHELOR OF SCIENCE** - in **AERONAUTICS (Avionics)** is my original work and it has not formed the basis for the award of any other degree.

Signature of student

(hariom kumar arya)

Place :- PUNE

Date :-

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Mr. Hariom Kumar Arya

Abstract –

There are too many technologies involved in todays Agriculture, out of which

Manual pesticide spraying causes many harmful side effects to the personnel involved in the spraying process. The Exposure effects can range from mild skin irritation to birth defects, tumours, genetic changes, blood and nerve disorders, endocrine disruption, coma or death. The WHO (World Health Organization) estimated as one million cases of ill affected, when spraying the pesticides in the crop field manually. This paved the way to design a drone mounted with spraying mechanism having 12 V pump, 6 Litre storage capacity tank,4 nozzles to atomize in fine spray , an octocopter configuration frame ,suitable landing frame, 8 Brushless Direct Current (BLDC) motors with suitable propellers to produce required thrust about 38.2 KG(at 100% RPM) and suitable Lithium- Polymer (LI-PO) battery of current capacity 22000 mAh .

To meet necessary current and voltage requirements. A First-Person View (FPV) camera and transmitter can also be fixed in the drone for monitoring the spraying process and also for checking pest attacks on plants. This pesticide spraying drone reduces the time, number of labour and cost of pesticide application. This type of drone can also be used to spray disinfectant liquids over buildings, water bodies and in highly populated areas by changing the flow discharge of the pump.

Key Words: DRONE, AGRICULTURE, PAYLOAD, SENSORS, PUMP, SPRAY

INTRODUCTION

The Indian Agricultural sector is the most important sector as it amounts to a staggering 18% of India's Gross Domestic Product (GDP) and also provides employment to 50% of the national human workforce. Our country is dependent on agriculture so much, has yet to tap into the real potential of agriculture, because of improper methods of monitoring crops and the irrigation patterns and the pesticides required to be applied. In India, there are over 35 drone start-ups that are working to raise the technological standards and reduce the prices of agricultural drones. This project aims to develop Unmanned Aerial Vehicle (UAV) for overcoming this problem and also spay large amounts of pesticides within smaller interval of time using Octocopter.

1.1 Literature Survey

Dongyan et al. (2015) [1] experimented on effective swath width and uniformity of droplet distribution over aerial spraying systems like M-18B and Thrush 510G.These agricultural planes flew at height of 5 m and 4 m respectively and with this experiment they reach to conclusion that flight height leads to the difference in swath width for M-18B & Thrush 510G.

Huang et al. (2015) [2] made a low volume sprayer which is integrated into unmanned helicopters. The helicopter has a main rotor diameter of 3 m and a maximum payload of 22.7 kg. It used to require at least one gallon of gas for every 45 minutes. This study paved the way in developing UAV aerial application systems for crop production with higher target rate and larger VMD droplet size.

Yallappa et al. (2017) [3] developed an hexacopter with 6 BLDC motors and two LiPo batteries of 6 cells- 8000 mAh. Their study also involves performance evaluation on discharge and pressure of spray liquid, spray liquid loss and determination of droplet size and density. Through their project, they finally made a drone capable of carrying 5.5 L of liquid with an endurance time of 16 min.

Kurkute et al. (2018) [4] worked on quadcopter UAV and its spraying mechanism using simple cost-effective equipment. The universal sprayer system is used to spray for both liquid and solid content. In their research, they have also compared different controllers needed for agricultural purposes and concluded that quadcopter system with Atmega644PA is the most suitable due to its efficient implementation.

Rahul Desale et al. (2019) [5] described an architecture based on UAV that could be employed for agricultural applications. Their UAV was designed not only for spraying but also for monitoring agricultural fields with the use of cameras and GPS. Their design was optimized for cost and weight. They used a microcontroller kk 2.1.5 which has inbuilt firmware. Prof. B. Balaji et al. (2018) [6] developed an hexacopter UAV with the purpose of spraying pesticides as well as crop and environment monitoring using Raspberry Pi that run on python language. Their UAV also contains multiple sensors like DH11, LDR, Water Level Monitoring sensors. From this experiment, they finally concluded that

with proper implementation of UAVs in the agricultural field almost 20%- 90% savings in terms of water, chemical maltreatments and labor can be expected.

DESIGN AND WORKING OF OCTOCOPTER

To Design an octocopter first we have to Estimate our payload, then with respect the weight of the payload motor, Propeller, Electronic Speed Controller, Pump, First Person View camera and video transmitter has to be selected. Battery has to be selected by knowing the current and voltage requirements of the components. Then the thrust requirement has to be calculated and finally the frame of the copter has to be designed by determining required arm number, arm length and application of payload.

Payload Estimation:-

The weight of the payload is calculated by taking the weight of the liquid (pesticide or disinfectant), storage tank of 6 Litre capacity, pump and nozzles.

Table - Data

PARTS	WEIGHT (grams)	1: Payload
0.6 Litre liquid	60	
1 Litre liquid tank	25	
pump	20	
Nozzle	30	

Construction:-

The prefix octo-copter implies (octo =eight), is a drone configuration where there are eight arms. The main frame is made of carbon fiber composite material with each arm length of 492 mm. At each free end of the arm, a motor will be fixed and propeller will be mechanically coupled to the motor. For all eight motors the output side of an ESC will be connected and the input side of the Electronic Speed Controller (ESC) will be connected to the flight controller. The other input of the ESC will be connected to the power distribution board where the power supply is provided by the Li-Po battery. In a similar fashion all the other ESCs, motors and propellers are connected. A receiver will be connected to the Flight controller to receive signals from the transmitter. An FPV camera and a suitable transmitter connected each other is connected to the flight controller. The storage tank of dimensions 200 x 300 x 110 mm is mechanically coupled to the frame, the bottom of the tank will have a slope so that the entire tank gets drained completely. A plastic tube of 1.3 meters length and four nozzles are fixed at 45cm between each other. A pump is powered from a power distribution board, the inlet of the pump is connected to the storage tank and the outlet is connected to the plastic tube where nozzles are fixed. The landing frame of height 300mm is connected to the main frame so that the landing of the drone will be safe and the storage tank will not touchthe ground.
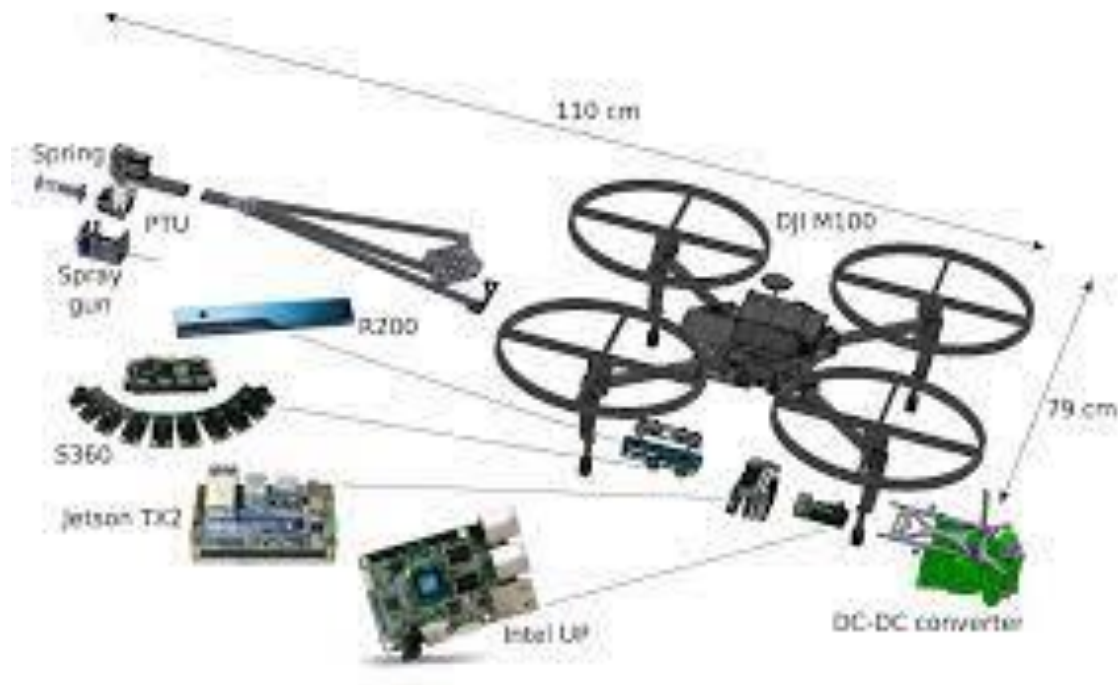

Fig.1 equipments

Working

The signals will be transmitted from Transmitter and it will be received by the Receiver in the drone. From the receiver the signal goes to the Flight controller where the signal will be processed with accelerometer and gyroscope sensors. The processed signal will be sent to the ESC, which allows the specific amount of current to the motor based on the signal it receives. The propellers are mechanically coupled to the motors so that they rotate and produce thrust. The FPV camera takes current supply from the flight controller and it records the video, the video signals will be processed by the transmitter and it will be received by the receiver in ground. The pump takes current supply from the Li-Po battery and pressurizes the liquid from the storage tank then the pressurized liquid flows through the pipeline and enters the nozzle then gets sprayed. The flow rate of the pump can be controlled by varying the input current which can be controlled from the transmitter.

Components Used

1. Motor

Outer runner BLDC motors in which there are no brushes, they have a permanent magnet. The RPM of the motor can be controlled by varying the input current. This motor T- MOTOR MN 7005 KV115 and P24x7.2F propeller produces a maximum thrust of 4783 grams.

Fig.2.Motor and propeller

Propeller

The propeller is of 24 inches length and has 7.2 inches pitch. It is made up of carbon fiber which possesses high strength to weight ratio when compared to the propellers made up of plastics.

1. ESC

   It stands for Electronic Speed Controller and it is used to vary the Revolution Per Minute (RPM) of the motor. 60A rated ESC is used as per the motor and battery specifications.

   Battery:-

The battery that can be used is a Li-Po battery of 22000mAh capacity and 22.2 V. In this battery six Li-Po cells are connected in series (6×3.7=22.2V).

Flight Controller

The flight controller helps in the maneuvering operations and also it provides Auto level function. The accelerometer and gyroscope sensors in the Flight controller processes the signals from the receiver and gives the output to the ESC. The KK 2.1.5 Flight controller board can be used in the drone as it has inbuilt firmware. The features of this Flight controller board are much easier for calibration. It uses ATMEL Mega 644PA 8-bit AVR RISC-based microcontroller with 64K of memory.

Fig3 . Flight controller

Radio Transmitter and Receiver:-

The Transmitter and receiver used are FlySky CT6B 2.4Ghz 6CH and FS-R6B respectively. This combination provides a range of about 1000 meters. This Transmitter and receiver provide upto 6 channel options.

Fig.4. Transmitter and receiver

Pump and Nozzle

To pressurize the liquid a 12 V DC water pump can be used which has 2.5 L/min capacity can be used. Then the pressurized liquid enters the nozzle and gets sprayed. The nozzle that can be used is a flat fan type for spraying the liquid. Four nozzles are connected with ducts and they are palace at 45cm distance between each other.

Fig 5. Pump and nozzle

Flat fan Nozzle

1.

1. Weight Build-up

   Table -2: Components Weight Datasheet

   The overall weight of the drone is calculated by adding the total weight of components and the weight of payload.

   Overall weight = Payload + Weight of components

   = 6750 + 5946

= 12,696 grams(approx.)

Fig.6 flat fan nozzle

1.   **Thrust** Calculation

Thrust developed at 100% RPM can be three times larger than the total weight of the drone so that the drone has better maneuverability and the drone can climb higher altitudes with higher rate of climb.

Thrust produced by one propeller with one motor= 4783 grams

Total thrust produced = 8 x 4783 = 38264 grams

Thrust to weight Ratio = Thrust produced / total weight of drone

= 38264 / 12696

= 3.01 : 1

Battery Drain Time Calculation

The Battery Drain time can be more than 10 minutes so that the drone drains the entire storage tank and it can be refilled for another serve. For a safer side, the battery drain time has to be calculated by considering the distance and time for the drone to return safely

.

Fig.7 Battery

Current Requirement Table:-

COMPONENT	CURRENT REQUIRED (Amp)
Motor	120
Receiver	0.1
Flight controller	0.1
ESC (8)	0.8
Camera	0.32
FPV transmitter	0.31
pump	5
TOTAL	126.63

Structural Description

There is no such generic frame which is considered to be best among all the frames, however it depends on a number of factors like multi-rotor configuration, rotating moment and balancing, application, material, stiffness and components integration. Depending on size and dimensions of selected electronic components, we designed a base plate in the shape of irregular octagon such that all components placed on the Centre of Gravity.

Fig.8 structural description

PARTS	WEIGHT (grams)
Frame	100 (Approx.)
Battery	50
Motor	150
ESC + power distributor	58
Propeller	44
Flight controller	2

Fig.9 working animation

CONCLUSION:-

In this paper we have described a design of a drone mounted spraying mechanism for Agricultural purpose and for spraying disinfectants. This method of spraying pesticides on Agricultural fields reduces the number of labours, time, cost and the risk involved to the personnel involved in spraying the liquids. This drone can also be used in spraying disinfectant liquids over buildings, water bodies and highly populated areas.

1. FUTURE SCOPE

1.

- Under the current COVID19 Pandemic situation, it can be used to sanitize large hotspots areas without actually going there in person.

- Manual control can be changed into autonomous control with GPS technology and auto return home

  option.

- With image processing techniques, the drone can be involved in surveillance to determine the pest attack on the plants, condition of ripening fruit.

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