Development & Implementation of UAV Mounted Sprayer in Precision Agriculture

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Abstract - *Agriculture is one of India's primary sources of revenue. Crop production rates in agriculture are influenced by a variety of factors such as temperature, humidity, and rainfall. These are natural elements that farmers have no control over. Agriculture is also influenced by a variety of elements such as pests, disease, fertilizers, and other factors that may be managed by properly treating crops. This study demonstrates how Unmanned Aerial Vehicles (UAV) may be utilized to decrease human effort in various activities such as UREA spraying, fertilizer spraying, feedstock monitoring, and so on. The creation of a quadcopter UAV and the spraying mechanism is described in this project. We also talk about how to integrate a sprayer module into a quad copter system. The proposed system entails creating a prototype with low-cost components such as a BLDC motor, Mission Planner, ESC wires, Telemetry, and GPS.*

***Key Words*: Agriculture, Unmanned Aerial Vehicle, Quadcopter, MissionPlanner.**

1.INTRODUCTION

An Unmanned Aerial Vehicle (UAV), in terms, is called a drone. UAV technology is a remarkable advancement that continues to have far-reaching implications in today's society and is changing our lives. The farming industry seems to have adopted drone technology along with advanced tools to transform modern agriculture.

Agricultural drones are used to bring about and increase cultivation, generally known as precision agriculture. This farming management technique is focused on sensing, calculating, and acting on real-time livestock and crop data. It eliminates the need for assumptions in modern farming, allowing farmers to maximize yields and operate more efficient organizations while increasing crop output. Drone applications in delivery, agriculture, and photography are all on the rise because of the declining drone development cost in the recent years.

In the year 2025, the agricultural drone industry is anticipated to grow by 35.9%. The necessity for effective farming will only grow in importance as a result of shifting climatic patterns and rising population levels.

Agricultural drones allow farmers to access a wealth of data that they can use to make better decisions, improve crop yields and thus increase overall profit. The information obtained may then be utilized to produce a more exact mapping of any current problems, as well as remedies based on more trustworthy data. Agriculture is no stranger to adopting new technological trends in order to run a more effective operation. Drones in agriculture are the next technology innovation that will assist farmers and agricultural businesses meet the future's changing and growing demands. Taking the above into consideration a UAV with a mounted tank and a sprayer system is developed.

2. METHODOLOGY

This section is dedicated solely to the techniques for assembling, refining, and flying the quadcopter mounted sprayer mechanism with autonomous flight control.

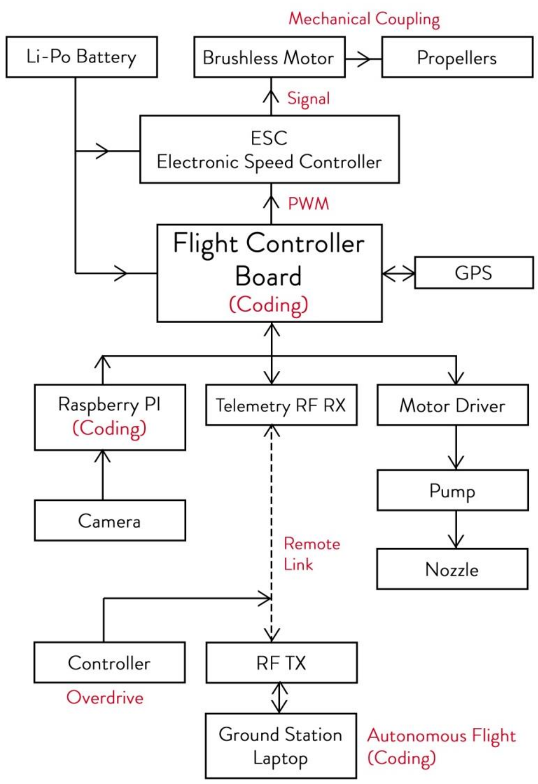

Figure -1: Block Diagram

- To achieve the project's goal, we either construct a UAV from the ground up or modify an existing drone.
- In an existing drone, flight controller should be inspected if it is able interface compass and send/retrieve data. If not, GPS and Telemetry are to be connected to the flight controller.
- Connection is as shown in Block diagram 1. The various components are as follows:
  Drone Frame - S550
  Propeller - 1045
  BLDC Motor - 1400KV
  Battery - LiPo 3S 2200mAh
  Electronic Speed Controller - 30A
  Flight Controller - APM 3.8
  GPS Module
  Telemetry - 433Mhz
  Remote Control - FlySky FS-i6
  Tank
  Pneumatic pump
  Brass nozzle
- Calibrating the drone by uploading code to microcontroller and running test flight.
- Connecting Sprayer module and balancing the drone.

2.1 Working:

- To fly, firstly make sure the RC controller is disarmed as a precautionary measure then connect the battery to the drone. The ESC beeps sound indicating various state such as Input Voltage, Abnormal throttle signal, Throttle stick is not in the zero position.
- To operate the drone in autonomous mode, connect the telemetry receiver to the ground station (laptop in our case) and toggle the programmable switch in the Remote controller to autonomous feature.
- The software used in the ground station is a full-featured ground station application for the open source autopilot project known as MissionPlanner. The window is as shown in figure 2.

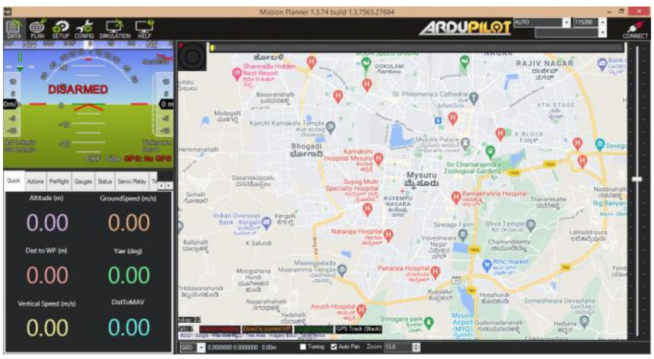

Figure -2: Software Window

- In the MissionPlanner software select 'Plan' and choose the location of spraying in the Google Maps window. Right click and select 'Auto WP' and pin-down the corner of the area want to be sprayed and click 'Enter'. For Example we have taken the garden area of NIE College, Mysuru and have created a path way for the drone to follow. Refer Figure 3.

Figure -3: Path creation

- Now, the points in the GUI are converted into GPS coordinates and are uploaded to the drone. The drone will not automatically fly, but rather we have to bring the drone to an acceptable height using manual control and then toggle to autonomous mode.
- Now, when the drone latches to the first point in the map, it starts the pump and sprays the liquid in the tank. The drone carries a payload (liquid) of 1 litre and has a total flight time of 15 min. In the case of landing, it is fully autonomous.

Note: A no-fly zone (red circles on the map), often known as an air exclusion zone, is a territory or region established by a military force over which certain aircraft, including drones, are not authorized to fly. The image is as shown in figure 4.

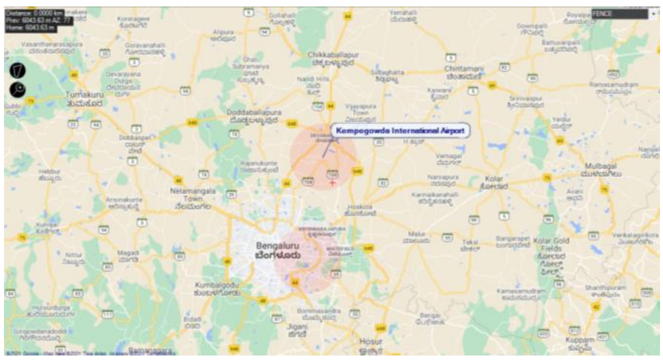

Figure -4: Restricted area

2.2 Calculation of Design Parameters:

Determination of payload, deadweight and total number of motors are required for the calculation of liquid flow measurement in LPM, thrust per motor, KV rating of motors and the size of propellers.

2.2.1 Calculation of Liquid Flow rate measurement:

Volume of Liquid = 1 litre
Total time taken to empty the tank = 3 min

Volume (l) / Time (min) = 1/3 = 0.33 LPM

2.2.2 Determination of Deadweight:

Table -1: Deadweight calculation

Sl. no.	Name of Component	Weight (gm)
1	Frame	760
2	Motor	360
3	Propellers	66
4	ESC	138
5	Flight Controller	82
6	Battery	175
7	GPS	45
8	Telemetry	36
9	Tank	157
10	Pump	111
11	Nozzle	20
Miscellaneous		61
Total		**2011 ≈2000**

2.2.3 Determination of Thrust per motor:

Deadweight of Drone = 2000 gm (from Table 1)
Payload = 1000 gm
Total Weight of Drone = 3000 gm
Number of Motors = 6

Thrust per motor =
(Total Weight of drone*2)/Number of motors
= (3000*2)/6 = 1000 gm/motor
Thrust per Motor = 1000 gm
Total Thrust to be produced = 6000 gm

Take rating of motor = 1400 KV
Take rating of battery = 3S

2.2.4 Determination of Propeller size:

By using trial and error method,
☒ Thrust produced by 0845 propeller: 550 gm
☒ Thrust produced by 0945 propeller: 650 gm
☑ Thrust produced by 1045 propeller: 1000 gm
Thus, to produce a total thrust of 6000 gm, the required specification is
Motor rating = 1400KV
Battery rating = 3S
Propeller size = 1045

3. RESULTS AND DISCUSSIONS

This section of the paper is dedicated to presenting the information in the most functional order possible, and it corresponds to the construction timeline. The partially assembled drone is shown in figure 5, It consists of all the parts except the spraying system.

Figure -5: Drone without tank

Figure 6 shows the completed project with the tank mounted in the centre below and spray nozzle system behind.

Figure -6: Drone mounted sprayer

3.1 Expenditure Cost Sheet

The expenditure which has been incurred in the development of the UAV is extracted from the invoices and shown in table 2.

Table -2: Expenditure calculation

Sl. no.	Name of Component	Cost (₹)	Quantity in units	Total cost
1	Frame	4800	1	4800
2	BLDC Motor	340	6	2040
3	Propellers	75	6	450
4	ESC	350	6	2100
5	FC	2700	1	2700
6	Battery	1200	1	1200
7	RC	4150	1	4150
8	GPS	1850	1	1850
9	Telemetry	1900	1	1900
10	Tank	200	1	200
11	Pump	250	1	250
12	Nozzle	50	1	50
Miscellaneous				1084
Total				**₹ 22774**
				$ 306

3.2 To fly the drone, the steps are as follows:

Step 1: Make battery connections to the drone and connect the ground station module of telemetry to laptop.

Step 2: Set way points in the MissionPlanner software and denote the co-ordinates of launch and landing. Press SEND and upload the code.

Step 3: Turn ON the remote controller and set it to Manual mode.

Step 4: Throttle up and fly the drone to a desired altitude and toggle the mode from Manual to Auto.

Now the UAV follows the path of the course and sprays the liquid medium and lands at the landing way point.

Step 5: After operation, disconnect battery from drone, turn OFF remote controller and remove the ground station module.

3.3 Experimental Results:

The hexacopter took off for a total flight of 9 minutes with a payload of 1kg. The payload tank in volume is 1litre with a spraying of 0.33 LPM which covered an area of 1000m^2. The tank emptied in under 3 minutes and the drone had to be re-filled for a total of 3 flights until the battery died. For testing the drone was flown at a height of 10 meters, but it has a maximum flying radius of 300 meters from the ground station (limited by telemetry). The above steps were followed to fly the drone and it was found that the results were satisfactory.

4. CONCLUSION

An Unmanned Aerial Vehicle was successfully built and tested which used drone technology to carry out autonomous flights which is very useful where human intervention is not possible for spraying of chemicals on crops including rice fields and orchard crops (which is compact) as well as crops under terrain lands. It sprays appropriate the amount of liquid, and decreases spraying time which reduces cost, increases efficiency and renders farmers with time for recreational use. The technology aids to develop the precision agriculture technique. It will use GPS to accurately route the land area of that particular farmer or agricultural businesses, irrespective of the field's shape. Because the farmer does not enter the field, it prevents humans from being exposed to very harmful pesticides, as well as encounters with venomous snakes.

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