



# IJRASET

International Journal For Research in  
Applied Science and Engineering Technology



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# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

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**Volume:** 14    **Issue:** IV    **Month of publication:** April 2026

**DOI:** <https://doi.org/10.22214/ijraset.2026.79394>

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# Fabrication of a Quadrotor Drone for Agriculture

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**Abstract:** Drones, also called Unmanned Aerial Vehicles (UAV), have witnessed a remarkable development in recent decades. In agriculture, they have changed farming practices by offering farmers substantial cost savings, increased operational efficiency, and better profitability. The goal of this project is to build, modify, and improve an existing agriculture quadcopter. The project used a Quadcopter material that included motors, electronics speed controllers, flight controller, batteries, a transmitter, a receiver, and a 3D printed frame. Individual Motor was tested with Arduino board and verified to work properly. Agricultural pesticides and seeds dispersal is a very labour-intensive task with various problems faced in manual process. Humans spraying may lead to inadequate spraying of pesticides in certain parts of field, also it is not safe to handle pesticides as exposure can cause skin and breathing problems in human. So, flapper mechanism was developed that consists of horizontal blade rotates while the pesticide from storage tank flow through the vacuum will be sprayed to the required place in field. This project aims to design an agriculture drone with additive manufacturing process. Various parts of drone like frame, flapper mechanism attached with storage tank is designed in the Autodesk FUSION software and then printed with the help of 3D printer (material-PLA), then they are assembled with addition to various component like servomotor etc. Overall, aim of the project is to develop a drone and spray the materials with the help of flapper mechanism.

## I. INTRODUCTION

Our nation's primary industry is agriculture, yet when it comes to adopting technologies for greater farm productivity, we still lag far behind other nations. The overall amount invested in the agriculture industry has expanded by 72 to 80% over the last 5 to 6 years. This investment's primary goal is to increase production by at least 70% by the year 2050. The most crucial component of smart farming and precision agriculture is remote sensing.

The future of remote sensing in Precision Agriculture and smart farming is thought to be UAV-based IOT technologies.

Because pesticides are the primary means of destroying pests, pesticides are a bigger problem for farmers than bugs. As a result, drones are employed to spray urea and pesticides to boost crop yield.

To design a drone first we have to calculate our payload, then with respect to the load of payload motor, electronics speed controller, Propeller, Battery has to be selected. Battery has to be selected by knowing the voltage and current requirement of the components. Then the thrust requirement has to be calculated and the design of frame decided by determining the required arm number, arm length.

## II. LITERATURE SURVEY

According to the WHO (World Health Organization), more than 1 million pesticide cases are reported annually. More than one lakh people die every year, mostly in underdeveloped nations, as a result of human handling and pesticides spraying. In addition to cancer, hormonal disruption, and issues with reproductive and foetal development, pesticide exposure has been linked to asthma, allergies, and hypersensitivity. The skin and eyes may become inflamed by other insecticides.

Prof. B. Balajiet. al [1] has described a design of an unmanned aerial vehicles (UAVs) that can be used to establish a control loop for agricultural applications, where UAVs are in charge of spraying chemicals on crops and monitoring both agricultural fields and the environment. However, UAVs will play a significant part in the future advancement of precision agriculture.

Karan Kumarshaw et. al [2] has described a design for a drone-mounted spraying system for disinfection and agricultural applications. This method of applying pesticides to agricultural fields cuts down on the amount of labour, time, expense, and risk to the people doing the actual spraying.

Kurkuteet. al [3] had worked on a basic, cost-effective quadcopter UAV and its spraying system. Both liquid and solid contents are sprayed using the universal spray technology. They have also compared several controllers required for agricultural applications in their research, and they have concluded that the quadcopter system with Atmega644PA is the most appropriate due to its effective implementation.

U.E Uche [4] had worked on a basic, cost-effective quadcopter UAV and its spraying system. Both liquid and solid contents have been sprayed using the universal spray technology.

The quadcopters system with Atmega644PA is the most appropriate due to its effective implementation, according to their research, which also examined various controllers required for agricultural uses.

### III. METHODOLOGY DESIGN OF AGRICULTURE DRONE

The 3D computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM) software Autodesk Fusion 360 is extremely potent. With the use of a single tool, users may design, simulate, and produce goods with this cloud-based software.

#### STEP- 1

Various parts of an agriculture drone like various parts like Arm, Baseplate, top cover, top plate, controller up & down parts, storage tank and seed dispersal system tool etc, are designed in the part modelling section of the CATIA software. Various commands like Extrude, Assemble, line, circle, spline, trim, constraints, insert is used to draw 2D shapes with required dimensions and by using extrude command they are extruded according to the required size.

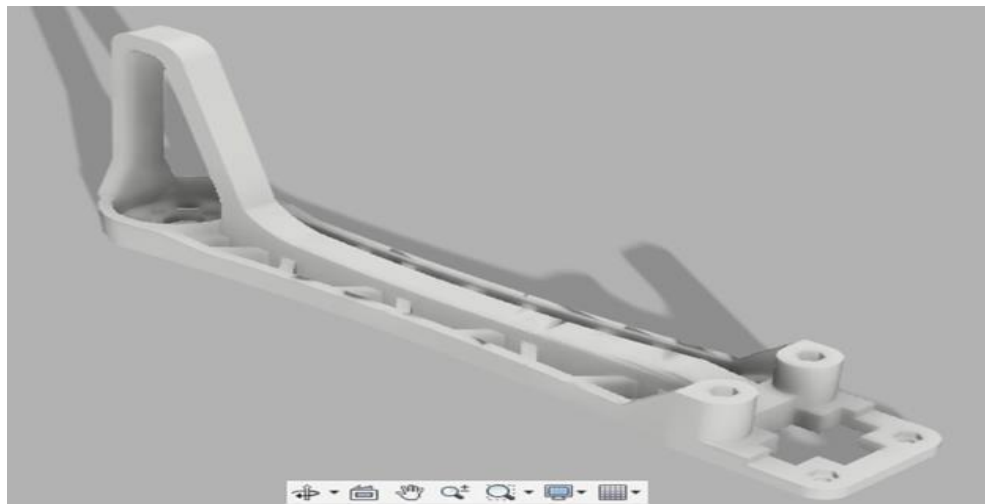


Figure 3.1 Arm

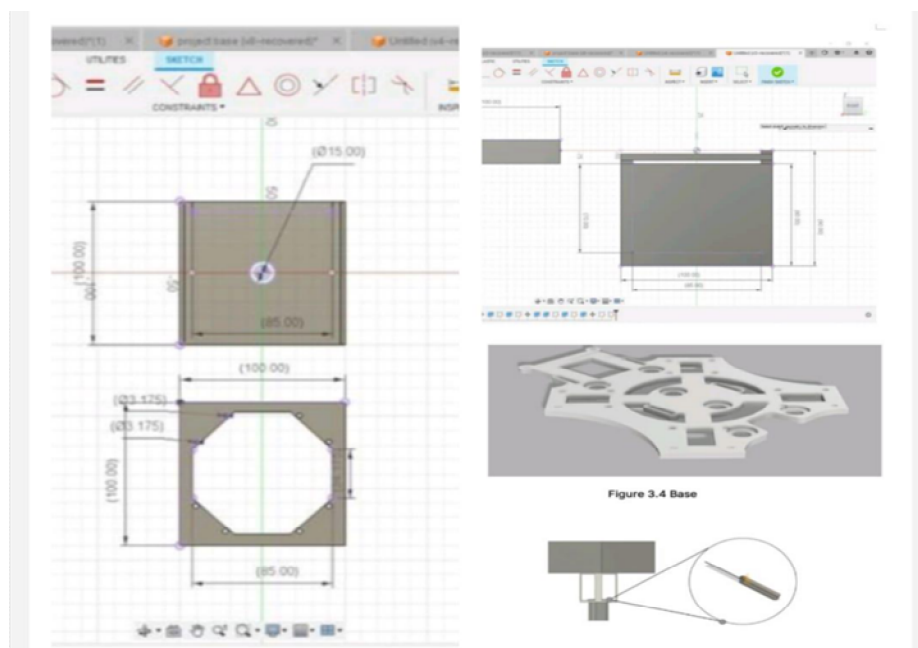


Figure 3.2

**STEP- 2**

Once the individual parts are redesigned in the sketch section, then some required sub-assemblies are made in the Assembly section of the FUSION 360 software. These sub-assemblies make the final assembly much easier.

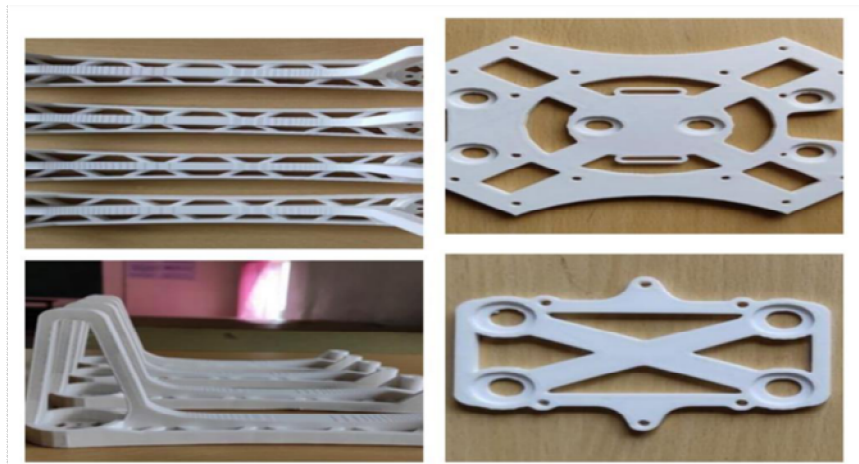


Figure 3.3 Flight Controller Support

**STEP- 3**

Finally, all the required individual parts and the sub-assemblies are inserted in the assembly section by using the “assemble command having joint & As-built joint, Rigid group” sub commands are used properly for design of the final assembly.

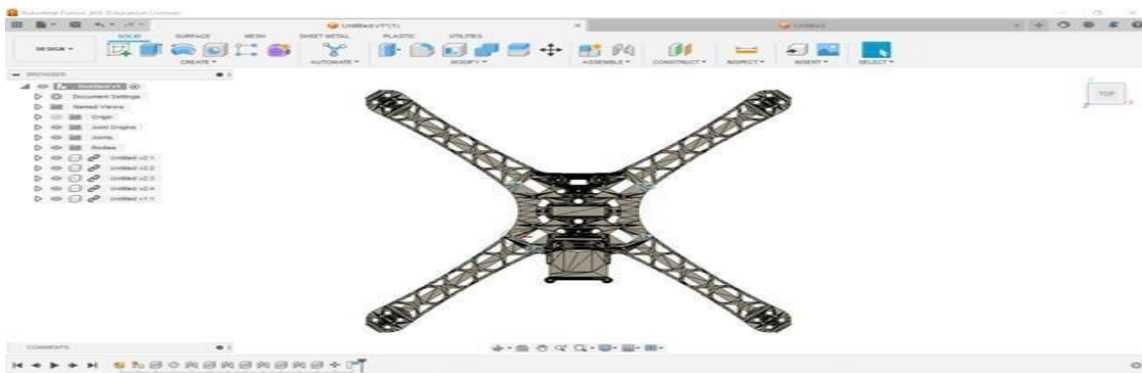


Figure 3.4 Top view of Drone

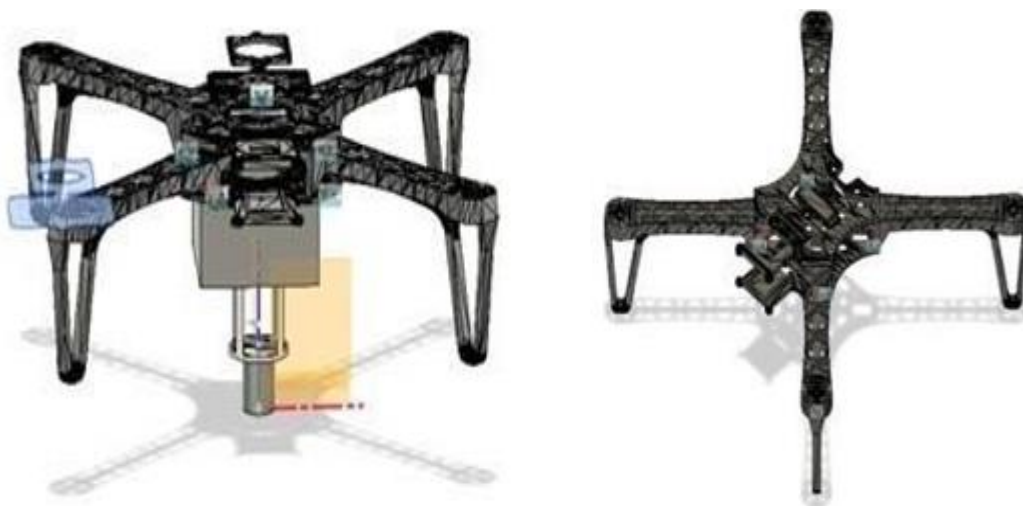


Fig 3.5 3D design of drone

#### IV. RESULTS AND DISCUSSIONS

A 3D printed frame can provide a number of advantages for an agricultural drone, including improved durability, reduced weight, and potential cost savings. In addition to extending flight time, a lighter drone can cover more ground more effectively. A seed dispersal system for urea fertilizer that incorporates a storage tank can deliver accurate and controlled fertilizer application, resulting in better crop yields and more effective resource usage. The fertilizer may be applied evenly and strategically using the seed dispersal system, which lowers waste and increases fertilisation efficiency overall.

The weight of drone along with payload (storage tank) consists of ~1.5kgs. Take-off of drone without payload after many unsuccessful attempts gives flight time of ~10 minutes, which is average outcome of a quadcopter. On other side, Testing is done manually with storage tank placing at certain height Fixed and done some trial-and-error method to find out speed required for servomotor to seed dispersing. Speed of servomotor with 60 value gives optimum outcome with dispersal of seed in closer range. With length of dispersal 1.27M. So drone stops at every ~1.30M range for seed dispersal for around 2 seconds. He attachment of both storage tank with drone eliminated the audio board connections as flight controller software operated by giving specific commands. This process resulted in decreasing of flight time as load on battery is more. Drone with payload results in unsuccessful attempt as there is mismatch in thrust of 1 St motor, replacing with other motor and proper ESC calibration gives proper take-off drone. Duration of the flight time is ~6 minutes with urea dispersal of 500 grams with a altitude hold of 2 Meters.

##### 1) Design & Structure

Lightweight frame using carbon fiber or aluminum for durability and reduced energy consumption. Four brushless DC motors with electronics speed controllers (ESCs) for stable flight.

Payload integration: pesticide/fertilizer spraying tanks (typically 1–5 liters capacity) mounted with pumps and nozzles.

##### 2) Performance Outcomes

3) Flight stability: Achieved through PID controllers and GPS modules for autonomous navigation.

4) Coverage efficiency: Spraying drones cover 5–10 acres per hour depending on tank size and battery capacity.

5) Precision agriculture: Equipped with cameras and sensors (NDVI, multispectral) for crop health monitoring.

##### 6) Cost & Energy

Fabrication cost is significantly lower than commercial agricultural drones when built with locally sourced materials. Battery endurance: 20–30 minutes per charge, requiring multiple batteries for extended field use.

##### Advantages

Reduces farmer exposure to harmful chemicals during pesticides spraying. Saves labor and time compared to manual spraying.

Enables precision farming by integrating sensors for crop monitoring. Environmentally friendly when optimized for minimal chemical usage.

##### Challenges

Battery limitations: Frequent recharging or swapping needed for large fields.

Payload constraints: Limited tank capacity restricts spraying duration.

Weather dependency: Wind and rain affects spraying accuracy and drone stability.

Maintenance: Requires technical knowledge for calibration and repair.

##### Future Improvements

Hybrid power systems (solar-assisted charging or fuel cells). AI-based autonomous navigation for obstacle avoidance.

Larger payload capacity with modular designs.

Integration with IoT for real-time data transmission to farmers

#### V. CALCULATIONS

##### Design Requirements (Assumed)

##### Parameter Value

Payload (pesticide tank) 10 kg  
Frame + electronics 5 kg  
Battery 5 kg

Total Takeoff Weight (MTOW) 20 kg

Number of motors 4

Configuration

X-type quadcopter

### Thrust Calculation

#### Rule:

For stable agricultural drones:  $= 2 \times \text{MTOW}$   
 (Safety factor = 2 for maneuvering & wind resistance)  $= 2 \times 20 = 40 \text{ kg thrust}$

**Thrust per motor:**  $\frac{40}{4} = 10 \text{ kg thrust per motor}$

So each motor must produce **minimum 10 kg thrust**.

### Motor Selection Calculation

Assume using 100KV–170KV brushless motors (common in ag drones).

Example class: 100KV motor with 30–34 inch propeller.

From typical performance charts:

- ☐ At 12S (44.4V)

- ☐ Current  $\approx 40\text{A} - 50\text{A}$

- ☐ Thrust  $\approx 10 - 12 \text{ kg per motor}$

Power per motor:  $P = V \times I =$

$$44.4 \times 45 = 1998 \text{ W} \approx 2 \text{ kW} \quad \text{Total power: } 2 \text{ kW} \times 4 = 8 \text{ kW}$$

### Battery Capacity Calculation

Assume:

- ☐ Total current  $= 45 \text{ A} \times 4 = 180 \text{ A}$

- ☐ Battery voltage  $= 44.4 \text{ V}$  (12S LiPo)

- ☐ Desired flight time  $= 12 \text{ minutes}$  (0.2 hr)

Required battery capacity:  $\text{Capacity} = \text{Current} \times \text{Time} = 180 \times 0.2$   
 $= 36 \text{ Ah}$  So required battery:

**12S 35Ah–40Ah LiPo**

Energy:  $E = V \times \text{Ah} = 44.4 \times 36 = 1598 \text{ Wh} \approx 1.6 \text{ kWh}$

### ESC Rating Calculation

Each motor current  $\approx 45 \text{ A}$

Safety margin 30%:  $ESC =$

$$45 \times 1.3 = 58.5 \text{ A} \quad \text{Select:}$$

**60A–80A ESC (HV compatible)**

### Propeller Calculation

Thrust equation:  $T = C_T \rho n^2 D^4$

Where:

- ☐  $C_T$  = thrust coefficient

- ☐  $\rho$  = air density ( $1.225 \text{ kg/m}^3$ )
- ☐  $n$  = revolutions/sec

- ☐  $D$  = diameter (m)

For heavy-lift drones:

Typical choice:

30–34 inch carbon fiber propeller

(0.76–0.86 m diameter)

Larger diameter  $\rightarrow$  Higher efficiency  $\rightarrow$  Longer flight time

#### FrameStrengthCalculation

Assumecarbonfiberamlength = 800mm  
 Loadper arm:  $\frac{20}{4} = 5kg$   
 Force:  $F = mg = 5 \times 9.81 = 49N$   
 Bendingmoment:  $M = F \times L = 49 \times 0.8 = 39.2Nm$

#### SpraySystemCalculation

Pump flowrate:  
 Assume spraying 1 hectare in 10 minutes.  
 Typical requirement:  
 5 L per hectare  
 For 10 L tank:

Covers 2 hectares per flight  
 flowrate:  $= \frac{10L}{10min} = 1L/min$

Cost Estimation (Approx.)  
 Total  $\approx$  \$3,000 – \$3,500

#### FinalSpecificationSummary

##### Parameter Value

MTOW 20kg Total Thrust 40kg  
 Motor 2 kW class Battery 12S36Ah  
 Flight Time 10–15 minutes  
 Spray Capacity 10 liters

## VI. CONCLUSION

In this project we have designed a DRONE WITH PESTICIDE SPRAYER by seed dispersal system which is an architecture built around unmanned aerial vehicles (UAVs) and a seeding system that may be used to construct a control loop for agricultural applications where a DRONE WITH PESTICIDE SPRAYER by seed dispersal system is in charge of sowing seeds. By doing this, we can minimize human effort to some extent, if not much. This will enable faster completion of the seeding process in agricultural fields. This will increase efficiency and improve accuracy while lowering labour costs. Within the signal's range, this is entirely controlled by the radio transmitter and receiver. The DRONE BASED PESTICIDE SPRAYER's seed dispersal system won't operate properly if we go too far outside of the signal range.

This system may be further developed in a number of ways, including by substituting other equipment or systems for the seeding system. For example, if a cutter is placed, the crop will be cut, if a sprayer module is attached to a drone, the drone will be used to spray pesticides, and if expensive equipment is provided, the system will also perform scanning of plants, security purposes, and inspecting crop details with specific seeds, fertilizers, and pesticides according to soil conditions. The wireless sensor network built at ground level on the agricultural field provides feedback that is used to regulate the application process.

Drones will be used in almost every sector of the economy, but drone usage in the agricultural industry is booming. Our cutting-edge platform is a key to enabling world-class practices for a safe, healthy and sustainable food supply chain.

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