# “DESIGN AND DEVELOPMENT OF UAV BASED PESTICIDES SPARYER IN AGRICULTURE APPLICATION”

A

Project Report

Submitted in the partial fulfillment of the requirements

For the Degree of

**Bachelor of Engineering**

**In**

**Electrical (Electronics & Power)**

By

**Mr. Amit Bahekar** **Mr. Gaurav Kedar** **Mr. Nishant Matode**

**Mr. Rohan Paralikar** **Mr. Sanket Wankhade** **Mr. Suraj Wagh**

Under the guidance of

**Prof. M. R. Chavan**

**DEPARTMENT OF ELECTRICAL ENGINEERING**

**SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING**

**SHEGAON 444 203 M.S (INDIA)**

**Session: 2022 - 2023**

DEPARTMENT OF ELECTRICAL ENGINEERING
SHRI SANT GAJANAN MAHARAJ COLLEGE OF ENGINEERING
SHEGAON 444 203 M.S (INDIA)

2022-23

# CERTIFICATE

Certified that the project report entitled, "DESIGN AND DEVELOPMENT OF UAV BASED PESTICIDES SPRAYER IN AGRICULTURE APPLICATION" is a bonafied work done under my guidance by

| | | |
|---|---|---|
| Mr. Amit Bahekar | Mr. Gaurav Kedar | Mr. Nishant Matode |
| Mr. Rohan Paralikar | Mr. Sanket Wankhade | Mr. Suraj Wagh |

In partial fulfillment of the requirements for the award of degree of Bachelor of Engineering in Electrical (Electronics & Power).

Date: 13/05/23

Prof. M. R. Chavan
Guide

Approved

(Dr. S. R. Paraskar)
Head
Department of Electrical Engg.

(Dr. S. B. Somani)
Principal

E-mail: principal@ssgmce.ac.in
hod_elpo@ssgmce.ac.in

Phone No. 07265-252116, 252216
Fax No. 07265-252346, 253602

## ACKNOWLEDGEMENT

We first pray to our divine source of inspiration “**Shri Sant Gajanan Maharaj**” whose blessings are always with us.

We express our deep gratitude to our Respected Director **Mr. Shrikantdada Patil** for his kind blessings, encouragement and providing us such a good opportunity.

No words could be good enough to express our deep gratitude to our respected **Principal Dr. S. B. Somani** for his kind blessings, inspiration and providing us the necessary support.

We feel great pleasure in expressing our deepest sense of gratitude and sincere thanks for valuable guidance, extreme assistance and cooperation extended to us by our **Guide Prof. M. R. Chavan** in preceding the completion of the project.

We are equally indebted to **Dr. S. R. Paraskar (Head, Electrical Engineering Department)** for extending necessary help, providing facilities and time-to-time valuable guidance. We are especially thankful to Prof. P. R. Bharambe, Prof. R. S. Kankale & Dr. A. U. Jawadekar for their valuable suggestions and inspiration time to time.

This acknowledgement would be incomplete without expressing our special thanks to Prof. A .B. Solanke and Prof. R. S. Pote for their support during the work.

Last but not least, we would like to thanks all the teaching, non-teaching staff members of the Electrical Engineering Department, our family members and colleagues those who helped us directly or indirectly for completing this task successfully.

1) Amit Bahekar
2) Gaurav Kedar
3) Nishant Matode
4) Rohan Paralikar
5) Sanket Wankhade
6) Suraj Wagh

# ABSTRACT

A pesticide spraying quadcopters, also known as an agricultural drone, is an unmanned aerial vehicle (UAV) that is designed for spraying pesticides and other agricultural chemicals over crops. These drones are equipped with specialized spray nozzles and tanks that can be filled with various types of pesticides and herbicides, allowing for precise and efficient application of these chemicals. One of the main advantages of using a pesticide spraying quadcopters in agriculture is the increased efficiency and accuracy of the spraying process. Drones can cover large areas of land quickly and can reach areas that may be difficult or impossible to access with traditional spraying equipment, such as steep or uneven terrain. Additionally, the use of drones can reduce the amount of chemicals needed for spraying, as the precision of the application allows for targeted spraying only where needed, minimizing waste and reducing the environmental impact. However, the use of pesticide spraying quadcopters also raises concerns regarding potential negative impacts on the environment and human health. Careful regulation and proper training of operators are necessary to ensure that these devices are used safely and responsibly. Overall, the use of pesticide spraying quadcopters in agriculture represents a promising technological development that has the potential to increase efficiency and reduce environmental impact in the field of crop management.

# CONTENTS

# LIST OF FIGURES

## CHAPTER 3



## CHAPTER 5

# LIST OF TABLES

# CHAPTER: 1

# INTRODUCTION

# CHAPTER 1

## INTRODUCTION

### 1.1. Background information on the use of drones in agriculture:

1. The use of drones, or unmanned aerial vehicles (UAVs), in agriculture has gained increasing attention in recent years due to their potential to improve efficiency, reduce costs, and increase yields. Drones can provide farmers with a bird's-eye view of their crops and fields, allowing them to quickly identify areas of stress or disease, monitor crop growth, and optimize irrigation and pesticide application.
2. One of the most promising applications of drones in agriculture is for spraying pesticides. Traditional methods of applying pesticides often require heavy machinery, which can damage crops and soil. By contrast, drones can precisely target specific areas with minimal soil compaction and reduced risk of drift, leading to more efficient use of resources and reduced environmental impact.
3. In addition to pesticide application, drones can be used for a range of other agricultural applications, including crop mapping, yield prediction, and livestock monitoring. They can also be equipped with sensors and cameras to collect data on soil moisture, temperature, and other environmental factors, which can be used to inform crop management decisions.
4. However, the use of drones in agriculture is still relatively new, and there are several challenges that need to be addressed. These include regulatory issues, such as airspace restrictions and certification requirements, as well as technical challenges, such as battery life and weather conditions. As the technology continues to evolve and become more affordable, it is likely that we will see increasing adoption of drones in agriculture in the coming years.

### 1.2 Overview of problem and opportunity addressed by project:

1. The problem that is addressed by the project on the use of quadcopters or drones in agriculture is the need for efficient and effective pesticide application methods. Traditional methods of pesticide application, such as ground-based equipment or aerial crop dusters, have limitations in terms of accuracy, speed, and environmental impact.
2. Using quadcopters or drones for pesticide application provides an opportunity to overcome these limitations and improve the efficiency and effectiveness of the pesticide application process. Quadcopters can be equipped with sensors and GPS technology that can precisely target areas of the field that require pesticide, while avoiding areas that do not. This reduces the amount of pesticide needed, resulting in cost savings and reduced environmental impact.
3. Additionally, quadcopters are capable of flying at low altitudes, which enables them to reach areas of the field that may be difficult to access with ground-based equipment or aerial crop dusters. This improves the speed and efficiency of the pesticide application process, as well as reduces soil compaction and crop damage.
4. Overall, the project on the use of quadcopters in agriculture for pesticide application addresses the need for a more efficient, effective, and sustainable method of pesticide application that can benefit farmers and the environment.

### 1.3. Project Objective and Scope :

The objective of the project on the use of quadcopters in agriculture for pesticide application is to design and develop a cost-effective and efficient system for precision agriculture. The scope of the project includes the following:

1. Design and construction of a quadcopter for pesticide application: The project will involve the design and construction of a quadcopter that is capable of carrying and spraying pesticides with high precision.

2. Testing and validation of the quadcopter or drone in different field conditions to ensure its effectiveness and efficiency
3. Development of a control system: The project will involve the development of a control system that can be used to program the quadcopter's flight path, as well as monitor and control the application of pesticides.
4. Testing and evaluation: The project will include testing and evaluation of the quadcopter system under different field conditions to ensure its effectiveness and efficiency.

### 1.4. Importance of the project to stakeholder

The project on the use of quadcopters in agriculture for pesticide application is important to a variety of stakeholders, including farmers, agricultural companies, and environmental organizations. Farmers stand to benefit from the project by having access to a more efficient and effective method of pesticide application that can improve crop yields and reduce costs. The use of quadcopters for pesticide application enables farmers to precisely target areas of the field that require pesticide, reducing the amount of pesticide needed and minimizing environmental impact. This can result in cost savings and increased profits for farmers. Agricultural companies can also benefit from the project by developing and offering new services to farmers. By developing and deploying quadcopter systems for pesticide application, agricultural companies can differentiate themselves from competitors and gain a competitive advantage in the market. This can result in increased revenue and growth opportunities. Environmental organizations can also benefit from the project by promoting sustainable agriculture practices. The use of quadcopters for pesticide application can help reduce the amount of pesticide needed, resulting in reduced environmental impact and improved soil health. This can help promote more sustainable and environmentally responsible farming practices. Overall, the project on the use of quadcopters in agriculture for pesticide application is important to stakeholders because it offers a more efficient and effective method of pesticide application that can improve crop yields, reduce costs.

## 1.5. Motivation

Traditional methods of pesticide or pesticide application are labour-intensive, time-consuming, and often inefficient. Manual spraying of pesticides or pesticides can lead to uneven application, resulting in crop damage and yield losses. The use of large-scale machinery, such as tractors or crop dusters, can be expensive and can cause soil compaction and other environmental issues. Quadcopter or drones offer a more precise and efficient alternative for pesticide spraying application, reducing labour costs and environmental impact.

# CHAPTER: 2
# LITERATURE REVIEW

# CHAPTER 2

## LITERATURE REVIEW

Literature review is useful to understand in the depth knowledge of problem and the proper formation. The following papers were obtained from variety of publications. Almost all the articles presented some new and relevant information's to help the project.

**1] Design and Fabrication of Pesticides Spraying Drone for Agriculture by Prof. Ravindra Shende , Lokesh Bhagat, et al**

In this paper the modern day agriculture discussed along with the design and fabrication of UAV and its application in the agriculture. Agriculture where spraying with pesticides using drones is one of the emerging technologies. Spraying with personal insecticide causes many harmful effects on the workers involved in the spraying program. Exposure effects can range from mild skin irritation to birth defects, tumors, genetic mutations, blood and nerve disorders, endocrine disorders, dehydration or death. The WHO (World Health Organization) estimated that as many as one million infected cases were sprayed with insecticides on the plant. This explored the design of a non- aircraft fitted with a 12 V sprayer, a 0.50gm Litre storage tank, 4 microphones for atomize with a good spray, an octocopter stop frame, a suitable seating frame, 8-Brushless Direct Current (BLDC) has suitable propellers to produce the required thrust of about 38.2 KG (100% RPM) and a suitable Lithium-Polymer (LI-PO) battery with a current capacity of 22000 mAh and 22.2 V to meet the required current requirements and voltage. The First-Person View (FPV) camera and transmitter can be adjusted and wireless to monitor the spraying process and monitor pest infestation on plants. This pesticide spray drone reduces the time, number of workers and the cost of installing a pesticide. This type of drone can also be used to spray disinfectant on buildings, bodies of water and in densely populated areas by altering the flow of pump discharge.

**2] Design and Modelling of an Affordable UAV Based Pesticide Sprayer in Agriculture Applications by Venkata Subba Rao and Srinivasa Rao Gorantla.**

The usage of multirotor helicopters in the agricultural system is increasing rapidly. In the present generation Automation is used in every industrial system but not much in agriculture. Till now most of the farmers are applying pesticides and pesticides manually in their fields especially in developing countries. This causes many health issues to them because of the chemicals they are using. In near future Unmanned Ariel Vehicles (UAVs) are used in the agricultural field for monitoring, analyzing the field, disease detection, detection of the faulty area, identifying the suitable pesticide and applying the pesticide in the affected area. Present spraying systems in quadcopters are manually controlled or semi-autonomous. In this project, UAV is used for agricultural spraying which can be done semi autonomously. This paper discussed the design of an UAV of 4.8kg lift capacity, within 1.8kg payload capacity. UAV is moved manually or semi-autonomously by using Mission planner software. In future, they would like to design fully autonomous UAV for agriculture pesticide spraying application.

**3] Quadcopter based Automatic Spattering of Pesticides and Pesticides by K. N. Baluprithviraj, P. Naveena, R. Palanisamy**

This paper aims to develop a variable pitch quad rotor capable of aggressive aerobatic maneuvers which stretch beyond the current abilities of typical fixed-pitch quad rotors. It is to downsize the human efforts in the agricultural field and also to reduce human health issues pertaining to pesticides by using the quadcopter for spattering the pesticides and pesticides. The power sprayer available in the markets is generally manual and the proposed method is automated, hence it can save much time for the farmers. Quadcopter is classified as rotorcraft, as opposed to fixed-wing aircraft because its lift is derived from four rotors. The proposed method is to use quadcopter as a sprayer. So that most of the physical work can be avoided this helps in reducing health issues pertaining to pesticides. Quadcopter flight control is implemented with the help of radio frequency and spraying can be automated with the help of quadcopter's altitude input to operate pump. The method is designed for the beneficial activities of the farmers in which they will use quadcopter for spraying pesticides and pesticides instead of using normal manual sprayers. This paper is made with pre planning that provides flexibility in operation. This innovation has made the more desirable and economical. Spattering of pesticides and pesticides is automated with the help of ARDU-IMU. This paper helps in reducing human efforts in agricultural fields to cover large areas, reducing health issues to farmers who were spraying pesticides and pesticides. It is designed with the advancement technology which is very much helpful to farmers in the agriculture. Since thee pesticides and pesticides are sprayed from lower altitude, environmental pollution can be reduced.

**4] Design and Development of a Drone for Spraying Pesticides, Pesticides and Disinfectants by Karan Kumar Shaw, Vimalkumar R.**

The paper discusses contemporary agriculture as well as the creation and use of unmanned aerial vehicles (UAVs) in agriculture. Drone pesticide spraying in agriculture is one of the newest technologies. Personal pesticide spraying has a number of negative impacts on the spraying program's employees. Mild skin irritation to birth abnormalities, tumours, genetic mutations, blood and nerve diseases, endocrine disorders, dehydration, and even death can result from exposure. Insecticides were sprayed on the plant, according to an estimate by the WHO (World Health Organization), killing up to one million instances of infection. This looked at the construction of a non-aircraft outfitted with a 12 V sprayer, 0.50 gramme tank, 4 microphones for optimal spray atomization, etc. a suitable lithium-polymer (LI-PO) battery with a current capacity of 22000 mAh and 22.2 V to meet the necessary current requirements and voltage, an appropriate octocopter stop frame, a suitable seating frame, and 8-Brushless Direct Current (BLDC) have suitable propellers to produce the required thrust of about 38.2 KG (100% RPM). To observe the spraying procedure and track insect infestation on plants, a wireless, adjustable first-person view (FPV) camera and transmitter are used. By using this drone to spray pesticide, you can apply pesticides more quickly, with fewer employees, and for less money. By changing the flow of the pump discharge, this sort of drone may also be used to spray disinfectant on structures, bodies of water, and in heavily inhabited regions.

**5] Unmanned Aerial Vehicles in Smart Agriculture: Applications, Requirements, and Challenges by Praveen Kumar Reddy Maddikunta, Saqib Hakak et.al**

In this paper the smart farming and its application are discussed, smart farming will reach each and every nook of the world. The prospects of using unmanned aerial vehicles (UAV) for smart farming are immense. However, the cost and the ease in controlling UAVs for smart farming might play an important role for motivating farmers to use UAVs in farming. Mostly, UAVs are controlled by remote controllers using radio waves. There are several technologies such as Wi-Fi or ZigBee that are also used for controlling UAVs. However, Smart Bluetooth (also referred to as Bluetooth Low Energy) is a wireless technology used to transfer data over short distances. Smart Bluetooth is cheaper than other technologies and has the advantage of being available on every smart phone. Farmers can use any smart phone to operate their respective UAVs along with Bluetooth Smart enabled agricultural sensors in the future. However, certain requirements and challenges need to be addressed before UAVs can be operated for smart agriculture-related applications. Hence, in this article, an attempt has been made to explore the types of sensors suitable for smart farming, potential requirements and challenges for operating UAVs in smart agriculture. We have also identified the future applications of using UAVs in smart farming. It is evident from the contents of the paper that application of UAV and related technologies has immense contribution in the enhancement and optimization of various processes involved in agriculture. The use of UAVs impact on the cultivation process by performing efficient monitoring and spraying activities thereby optimizing the capabilities of pesticides. The strength of the paper lies in the presentation of Potential case studies involving Bluetooth Smart-enabled sensors and UAVs in smart agriculture which have been discussed explicitly. Bluetooth Smart technology can be replaced with any other technology for implementation purposes.

**6] An adaptive approach for UAV-based pesticide spraying in dynamic environments by Bruno S. Faical, Heitor Freitas, et.al**

This paper proposes AdE, a system that can adapted the route correction rules of a UAV pesticide spray in different weather conditions. This system consists of two elements: (i) CollAct, which is responsible for checking the weather of the crop field and updating the route Changing Factor parameter defined in the UAV's control system; and (ii) OPTIC, responsible for optimizing the route Changing Factor parameter to adjust the intensity of the route correction according to the sensored weather conditions. During the AdEn system design, the importance of an efficient optimization process was observed thus, when validating the proposal and evaluating the progress made, four metaheuristics were assessed as components of the AdEn system. The accuracy of the pesticide spray provided by the values optimized with these metaheuristics was evaluated. The results of the experiments demonstrated that the proposed AdEn system presented a good performance in the tested scenario, since it uses the control station to process most of the workload. Furthermore, the proposed metaheuristic, GA-IND10_GEN25 (set by the Grid Search technique), was shown to be more efficient and stable than other solutions found in the literature. In addition to the good results and progress achieved in this work, it opened up several opportunities for further studies, such as:

i. The development of a computer model for pesticide spraying with lower computational costs.

ii. The optimization of other parameters (e.g. height and speed of the UAVs) to reduce errors in pesticide deposition.

iii. Investigation of specific characteristics of optimization techniques for dynamic environments.

iv. An investigation of the scalability of the proposed system for implementing a fully-featured prototype model.

v. Study on the suitability of different dispersion models to make the most accurate computer model the real environment.

**7] Drones for Smart Agriculture: A Technical Report S. R. Kurkute, B. D. Deore et.al**

In this paper, they have discussed different architecture based on unmanned aerial vehicles (UAVs). The use of pesticides in agriculture is very important to agriculture and it will be so easy if will use intelligent machines such as robots using new technologies. This paper gives the idea about various technologies used to reduce human efforts in various operations of agriculture like detection of presence of pests, spraying of UREA, spraying of pesticides, etc. This paper describes the development of quad copter UAV and the spraying mechanism. In this paper we also discuss integration of sprayer module to quad copter system. The discussed system involves designing a prototype which uses simple cost effective equipment like BLDC motor, Arduino, ESC wires, etc. In this manuscript different types of system useful for Agriculture wonder drone system using micro-controller 8051, Agriculture wonder drone system using Atmega 328 microcontroller and Agriculture drone system using GPS were discussed. Mainly the paper focused on selection of best compatible design for Drone system for Agriculture purpose. Some of the exiting implementation was discussed with their advantages and disadvantages. Finally it is conclude that if the system design with the use of Atmega 644PA then it will be the more efficient implementation. In line to this the experimentation and expected result also discussed for further implementation.

**8] An Autonomous UAV for Pesticide Spraying by Kislaya Anand, Goutam R.**

In order to address the issue of agricultural spraying, this research paper suggests a brand-new task assignment mechanism. To confirm the logic and accuracy of this strategy, a simulation platform is set up and several simulations are run. The major goal of this strategy is to reduce the amount of time needed to accomplish the spraying mission while using plant-protection quadcopters to apply pesticides to a rectangular area. The findings of this study demonstrate that by employing the ideal mission assignment method, each quadcopter's mission time and execution will be quite near to one another. There are still several areas that need to be addressed, despite the fact that this approach offers some optimal simulation results in this study. Firstly, this plan is only appropriate for farmland that is rectangle because the majority of actual farmland is not square. In order for this plan to work on the uneven farms, it must be enhanced. Secondly, a quadcopter could be unexpectedly damaged and rendered useless in use. Future study on this plan should thus take quadcopter failures into account.

**9] Stability Analysis of a Sprayer UAV with a Liquid Tank with Different Outer Shapes and Inner Structures by Shibbir Ahmed, Huang Xin et.al.**

This research paper discusses the trajectory problem of UAV and gives the effective solution against sloshing effect in the UAV. The performance of sprayer UAVs largely depends on accurate trajectory control while spraying. A large amount of a liquid payload may create a sloshing effect inside the liquid tank, which may occur largely during hazardous phenomena, such as wind gusts and obstacle avoidance. This all-way sloshing force inside the tank may disturb the UAV’s trajectory. A large number of existing sprayer UAVs already carries various-shaped tanks. A UAV’s liquid-sloshing problem must be reduced for existing and future plant protection. Applying suitable methods can achieve these goals and provide better performance. Moreover, various tank models have different structures and capabilities, which must be fixed using a flexible solution. This research paper proposes a simple baffle solution for all forms of pesticide tanks and compares baffle systems’ impacts using primary shaped tanks. The stabilization of drone by analysis evaluation uses three primary tank shapes—rectangular, flat hexagonal, and horizontal cylindrical. Whereas the baffle ball and baffle wall both the anti-slosh technique shows good result. However, a simple baffle ball is more effective than the baffle wall and can be used in existing UAV tanks of any shaped tanks. On average, flat hexagonal tanks are more appropriate than rectangular and cylindrical tanks for sprayer UAVs.

**10] Application of drone in agriculture: A review by Gopal Dutta and Purba Goswami.**

This paper summarizes the current state of drone technology for agricultural uses, including crop health monitoring and farm operations like weed management, Evapotranspiration estimation, spraying etc. The objective of this paper is to review the usage of Drones in agriculture applications. Drones have great potential to transform Indian agriculture. With the advancement of technology in the future, the production of drones is expected to become economical. The modern youth are not attracted towards farming due to hard work and drudgery involved in it. The implication of drones may fascinate and encourage the youth towards agriculture. Drones provide real time and high quality aerial imagery compared to satellite imagery over agricultural areas. Also, applications for localizing weeds and diseases, determining soil properties, detecting vegetation differences and the production of an accurate elevation models are currently possible with the help of drones. Drones will enable farmers to know more about their fields. Therefore, farmers will be assisted with producing more food while using fewer chemicals. Nearly all farmers who have made use of drones have achieved some form of benefit. They can make more efficient use of their land, exterminate pests before they destroy entire crops, adjust the soil quality to improve growth in problem areas, improve irrigation to plants suffering from heat stress and track fires before they get out of control. Therefore, drones may become part and parcel of agriculture in the future by helping farmers in managing their fields and resources in a better and sustainable way.

# CHAPTER: 3
# QUADCOPTER COMPONENTS

# CHAPTER 3

# Quadcopter Components

**1) Frame -** Quadcopter frames come in different shapes and sizes, and are made from various materials such as carbon fiber, aluminum, plastic, and wood. The choice of frame depends on the application and the desired performance of the quadcopter. Here are some common types of frames used in quadcopters:

**X-Frame:** The X-frame is a popular choice for quadcopters because it provides good stability and allows for easy access to the electronics and battery. It has four arms arranged in an "X" shape, with two arms at the front and two at the back.

**H-Frame:** The H-frame has four arms arranged in an "H" shape, with two arms at the front and two at the back. It provides good stability and is suitable for larger quadcopters.

**Y-Frame:** The Y-frame has three arms arranged in a "Y" shape, with two arms at the front and one at the back. It is a simple and lightweight design that is suitable for smaller quadcopters.

**T-Frame:** The T-frame has four arms arranged in a "T" shape, with two arms at the front and two at the back. It provides good stability and is suitable for larger quadcopters.

**Foldable Frame:** Foldable frames are becoming increasingly popular because they are easy to transport and store. They typically have arms that can be folded inwards when not in use.

These are just a few examples of the types of frames used in quadcopters. The choice of frame depends on factors such as the intended application, the desired performance, and the available budget.

There are several reasons why an X-frame might be preferred over other types of frames for a quadcopter:

1. **Durability:** The X-Frame is known for its durability due to the fact that the arms

are connected in the center, which distributes forces and stresses evenly across the frame. This design also provides a stronger platform for the motors to be mounted on, resulting in less vibration and smoother flight.

2. **Versatility:** The X-Frame is a popular choice among drone enthusiasts because of its versatility. It can accommodate a wide range of motor sizes and propeller configurations, making it suitable for various applications and payloads.
3. **Accessibility:** X-Frame quadcopters are relatively easy to build and maintain due to their simple design. This means that replacement parts are readily available, and repairs can be easily carried out by the owner.

Overall, the X-Frame is a popular choice among drone pilots because it offers a balance of durability, stability, and versatility.

**Figure 3.1 X- type of frame**

**2) BLDC MOTOR** - BLDC (Brushless Direct Current) Motors are commonly used in drones due to their high efficiency, compact size, and low weight. They consist of a rotor with permanent magnets and a stator with windings. When the windings are energized with electric current, they create a rotating magnetic field that interacts with the magnets on the rotor, causing it to rotate. The main factors to consider when selecting a BLDC motor for a drone are its size, weight, power output, and efficiency. Generally, larger motors can provide more thrust but are also heavier, which can reduce flight time. The power output of a motor is usually measured in terms of its maximum current and voltage, which determines the amount of power it can provide. The efficiency of a motor is a measure of how much of the electrical power it consumes is converted into mechanical power, and higher efficiency motors are preferred for longer flight times. Some popular BLDC motor models used in drones include the T-Motor MN2212 KV920, the Sunnysky X2212 KV1400, and the DJI E310. The prices of these motors can range from around $10 to $50 per motor, depending on the brand and specifications. It is important to match the motor specifications with the requirements of the drone, such as the weight of the quadcopter and the size of the propellers used, to ensure optimal performance and efficiency. Additionally, proper maintenance and handling of the motors is important to ensure their longevity and reliability.


**Figure 3.2 BLDC motor**

**3) ESC (Electronic Speed Controller)** - ESC (Electronic Speed Controller) is a crucial component of a quadcopter that controls the speed of the motor. It interprets signals from the flight controller and adjusts the motor speed accordingly. Here are some important points to note about ESCs in quadcopters:

**1. Types of ESCs:** There are two main types of ESCs used in quadcopters - brushed and brushless. Brushed ESCs are used in brushed motors, while brushless ESCs are used in brushless motors. Brushless ESCs: Brushless ESCs are used in most quadcopters, as they are more efficient and provide better performance. They use a three-phase motor and rely on electronic commutation to control the motor speed.

**2. Features of ESCs:** ESCs come with a range of features, such as programmability, BEC (Battery Eliminator Circuit), and telemetry. Programmable ESCs allow the user to adjust parameters such as motor timing and throttle response. BEC circuits provide power to the flight controller and other electronics, eliminating the need for a separate battery. Telemetry-enabled ESCs provide real-time data on motor temperature, RPM, and voltage.

**3. Sizing ESCs:** It is important to select an ESC that is appropriately sized for the motor it is driving. The maximum current draw of the motor should be less than the maximum current rating of the ESC. Oversized ESCs can lead to unnecessary weight and reduced flight time.

**4. Calibration:** Calibration is an important step in setting up the ESCs for a quadcopter. This involves setting the minimum and maximum throttle values for each ESC, so that the flight controller can interpret the signal correctly. Calibration can be done using the flight controller software or a separate ESC programming tool.

Overall, ESCs are a critical component of a quadcopter, and selecting the right ESC for the motor is important for achieving optimal performance and efficiency.


**Figure 3.3 ESC(Electronic Speed Controller)**

**4) Flight controller** - The KK 2.15 flight controller is a small circuit board that is responsible for controlling the motors of a quadcopter. It receives input from various sensors, such as accelerometers and gyroscopes, and uses this information to stabilize the quadcopter in flight. It also provides features such as automatic leveling and altitude hold, which can make flying a quadcopter easier for beginners.

1. Some of the features of the KK 2.15 flight controller include:
2. Built-in LCD screen for easy setup and configuration

3. Support for up to 8 channels of RC input.
4. Multirotor firmware that supports quadcopter, tricopter, and other configurations.
5. Automatic level mode for easier flying.
6. Adjustable gains for tuning the flight characteristics of the quadcopter.

Overall, the KK 2.15 flight controller is a popular choice for hobbyists and DIY enthusiasts who are looking to build their own quadcopters. Its open-source design and low cost make it an attractive option for those who want to experiment with customizing their quadcopter's flight characteristics. The KK flight controller is a popular open-source flight controller used in quadcopters and other multirotor vehicles. It was developed by Rolf Blomgren and has been widely adopted by hobbyists and enthusiasts due to its simplicity and affordability.

The KK flight controller uses a gyroscopic sensor to determine the orientation and stability of the quadcopter. It also features a built-in accelerometer and a barometer to help stabilize the aircraft and maintain its altitude. The KK board is a circuit board that has a microcontroller, gyroscope, accelerometer, and other sensors that communicate with the motors and ESCs. It interprets signals from the receiver and uses the sensors to determine the orientation and stability of the quadcopter. The microcontroller then adjusts the speed of each motor accordingly to maintain stability. The KK flight controller has a simple user interface and can be programmed using a USB cable and a computer. It also supports a range of flight modes, including manual, stabilized, and acrobatic modes. One of the advantages of the KK flight controller is its affordability. It is relatively cheap compared to other flight controllers, making it an attractive option for beginners and hobbyists. It is also simple to use and program, which makes it ideal for those who are new to the hobby. However, the KK flight controller has some limitations Overall, the KK flight controller is a reliable and affordable option for quadcopter enthusiasts and hobbyist who are looking for a simple and easy-to-use flight controller.

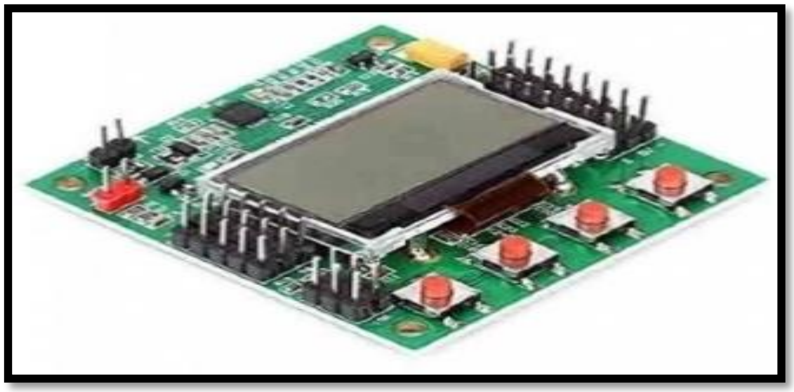

**Figure – 3.4 Flight controller**

**5) Battery** - 12V 2200mAh refers to a battery with a voltage of 12 volts and a capacity of 2200 miliampere-hours (mAh). This type of battery is commonly used in various applications, including portable electronics, RC vehicles, and backup power supplies. The voltage and capacity of a battery determine its energy storage capacity, which is measured in watt-hours (Wh). A 12V 2200mAh battery can store a maximum of 26.4 Wh of energy (12V x 2.2Ah). The actual runtime of a device using this battery will depend on its power consumption and efficiency.


**Figure – 3.5 Battery**

**6) Propeller** - The 1045 propeller is a type of propeller commonly used in quadcopters and other multirotor drones. The "1045" refers to the dimensions of the propeller, with the first two numbers representing the length of the propeller in inches and the second two numbers representing the pitch (or angle) of the blades in inches. Therefore, the 1045 propeller has a length of 10 inches and a pitch of

4.5 inches. This propeller is typically made of lightweight materials such as plastic or carbon fiber, and is designed to spin at high speeds to generate lift and thrust for the quadcopter. The 1045 propeller is compatible with a wide range of motors and can be used for both indoor and outdoor applications, depending on the size and weight of the quadcopter. When selecting a propeller for a quadcopter, it is important to consider factors such as the size and weight of the drone, the desired flight characteristics (such as speed or agility), and the type of motor being used. Using the wrong propeller can result in poor performance or even damage to the quadcopter

**Figure – 3.6 Propeller**

**7) FS-R6B receiver and transmitter -** The FS-R6B is a 6-channel receiver commonly used in quadcopters. It operates on a frequency range of 2.4GHz and uses the AFHDS (Automatic Frequency Hopping Digital System) protocol for reliable and interference-free communication with the transmitter.

The FS-R6B receiver is compact in size and lightweight, making it suitable for use in small drones. It has a high receiving sensitivity and can operate at distances of up to 500 meters in open areas, which makes it suitable for outdoor applications.

The receiver is easy to install and has a bind button that allows it to be easily paired with the transmitter. It also has a failsafe function, which ensures that the drone will automatically return to a safe position if it loses contact with the transmitter.

Overall, the FS-R6B receiver is a reliable and affordable option for controlling the flight of a quadcopter.


**Figure – 3.7 FS-R6B receiver and transmitter**

# CHAPTER: 4

# CALCULATIONS AND COST ESTIMATION

# CHAPTER 4

## Calculations

**1) Weight estimation –**

$W_{total} = W_{electronics} + W_{structural}$

Wstructural = 300 gm (Body Weight)

Welectronics = (800)gm (from given Specification of selected Electronics)

Wtotal = 800 + 300

Wtotal = 1100 gm

Thrust/Weight ratio in case of Quadcopter is almost 200%

Total thrust = 2*1100=2200gm

thrust of one motor =2200/4=550gm

hence we need a motor with 550gm thrust.

we finalized the Motor 980kv Sunnysky Motor

Max Current Draw = 15A,

Thrust= 800-1000 gm

Recommended Propeller = 10*4.7 inches

ESC: 4*30A

Battery: 3000mAH 3S-11.1v & 20C (Charging Rate)

| Prop | Volts ( V ) | Amps (A ) | Watts (W ) | Thrust (g ) | Efficiency (g/W ) |
|---|---|---|---|---|---|
| | 8.5 | 6.5 | 55 | 420 | 7.63 |
| 9047 | 1011.1 | 8.29.6 | 82106.5 | 560680 | 6.826.38 |
| | 12 | 11.0 | 132 | 740 | 5.60 |
| | 7.4 | 7.4 | 54.7 | 480 | 8.77 |
| 1047 | 8 | 8.2 | 65.6 | 520 | 7.90 |
| | 10 | 11.2 | 112 | 720 | 6.42 |
| | 11.1 | 13.2 | 146.5 | 870 | 5.93 |
| | 8.5 | 12.0 | 102 | 680 | 6.66 |
| 1145 | 10 | 14.2 | 142 | 880 | 6.19 |
| | 11.1 | 17.2 | 190.9 | 960 | 5.02 |

**Table 4.1 BLDC motor datasheet**

As you can notice ESC (30A) Current rating is higher than motor current draw (15A). If you selected an ESC with Lower Current Rating it may get damaged.

We can select the drone parameter by using above BLDC motor data sheet

**1) Motor Specification**

- Motor KV: 1400
- Model: X2220
- Diameter: 22mm
- Height: 30mm
- Weight: 80g
- Suitable for RC Airplane or Multi rotor helicopter
- 9045 /1047 Propeller, Esc between 40A and 60A are recommended

**2) ESC Specification**

- Input voltage: 6-12.6V(2-3S lipo)
- Continuous current: 40A
- Burst current: 60A
- Linear BEC: 3A/5V
- Weight: 50g

**3) Propellers for Multi-Copter (10×4.5 SF)**

- Rotation: Counterclockwise
- Length: 10 inches
- Pitch: 4.5 inches
- Type: Propeller Adapter
- Adapter Diameter: 3, 4, 5, 6mm (selectable ring)
- Weight: 8 g

**4) KK2.1.5 Multi-rotor LCD Flight Control Board**

- Size: 50.5mm x 50.5mm x 12mm
- Weight: 21 gram (Inc Piezo buzzer)
- IC: Atmega644 PA
- Gyro/Acc: 6050MPU InvenSense Inc.
- Auto-level: Yes

- Input Voltage: 4.8-6.0V
- AVR interface: standard 6 pin.
- Signal from Receiver: 1520us (5 channels)
- Signal to ESC: 1520us
- Weight: 50 grams

## 5) Battery Specification

| | | | |
|---|---|---|---|
| **Capacity** | 3000mah | **Voltage** | 11.1V |
| **Continuous discharge rate** | 25C | **Max burst rate** | 50C |
| **Configurations** | 3S1P | **Charge rate** | 1C |
| **Size** | (H)20mm*(W)44mm*(L)135mm | **Weight** | 247g |
| **PVC Color** | Blue | **Connector** | XT60 |

Also we can easily calculate maximum current that a battery can provide by following method

Max Current Supply = Battery mAH Rating * Battery C rating/1000

Max Current Supply = 3000*25 / 1000 = 75A

Similarly,

Flight Time = Battery mAH Rating / 1000 X (Motor Current Draw)

= 3000 / 1000 X 12 = 0.25 hr = 15min

**For Payload Capacity = 1 Kg**

Total Weight = Body Weight + Electronics Weight + Extra Weight on Quadcopter

= 300 + 800 + 1000

Total weight Actual = 2100 gm

= 2.100 kg

But we consider 2*2100 = 4.200 kg (Double Weight)

We Consider

So we have 4 brushless motor we required 1 motor given at least Trust - 1050gm

= 4 brushless Motor * 1050gm Thrust

= 4200gm

**6) Propeller Blade:**

Propeller Size 10*4.5

Diameter 10 inch

Pitch 4.5, meaning progress 4.5 inches per rotation

First number (10) will give you more thrust

Second number (4.5) will give you more speed

**Cost estimation of UAV for 1 kg payload and 5 kg payload**

| Name of component | Cost For 1kg | Cost For 5kg |
|---|---|---|
| Frame | 970 | 4300 |
| Motor | 1200*4 | 3200*6 |
| ESC | 519*4 | 1900*6 |
| Propeller | 100*4 | 320*6 |
| Sprayer | 900 | 1200 |
| Receiver | 1000 | 1000 |
| Transmitter | 10000 | 10000 |
| Flight Controller | 4500 | 15000 |
| Battery | 2700 | 3900 |
| Total | 27346 | 67920 |

**Table 4.2 Cost estimation table**

# CHAPTER: 5

# METHODOLOGY

# CHAPTER 5

## Methodology

Overall, the quadcopter components and pesticide spraying system are carefully chosen and integrated to optimize performance, accuracy, and reliability for the project on the use of quadcopter in agriculture for spraying pesticide application. The methodology used to design and build the quadcopter for pesticide application in agriculture involved several steps, including:

1. **Needs Assessment:** The project team conducted a needs assessment to identify the specific requirements and constraints for the quadcopter system, including flight time, payload capacity, spraying pattern, and environmental considerations.
2. **Conceptual Design:** The team used the information from the needs assessment to develop a conceptual design of the quadcopter system. This involved selecting the appropriate components, determining the placement and orientation of the components, and developing a preliminary design for the pesticide spraying system.
3. **Detailed Design:** With the conceptual design in place, the team proceeded to develop a detailed design for the quadcopter system. This involved specifying the dimensions, weight, and other parameters for each component, as well as determining the power requirements and electrical connections.
4. **Component Selection and Integration:** Based on the detailed design, the team selected the appropriate components for the quadcopter system, including the frame, motors, flight controller, battery, and sensors. The components were integrated into the quadcopter system, and the wiring and electrical connections were carefully installed.
5. **Testing and Evaluation:** Once the quadcopter system was assembled, it underwent a series of tests and evaluations to ensure that it met the performance requirements and environmental considerations. The team tested the flight characteristics, stability, and maneuverability of the quadcopter, as

well as the accuracy and precision of the pesticide spraying system.

6. **Optimization and Refinement:** Based on the results of the testing and evaluation, the team optimized and refined the quadcopter system to improve its performance, accuracy, and reliability. This involved making adjustments to the flight controller settings, refining the spraying system design, and making any necessary changes to the component selection and integration.
7. Overall, the methodology used to design and build the quadcopter for pesticide application in agriculture involved a careful and iterative process of needs assessment, conceptual and detailed design, component selection and integration, testing and evaluation, and optimization and refinement. This approach helped to ensure that the quadcopter system was optimized for performance, accuracy, and reliability for its intended application in agriculture.

# CHAPTER: 6

# BLOCK DIAGRAM

# AND

# CIRCUIT DIAGRAM

# CHAPTER 6

## Block diagram and circuit diagram

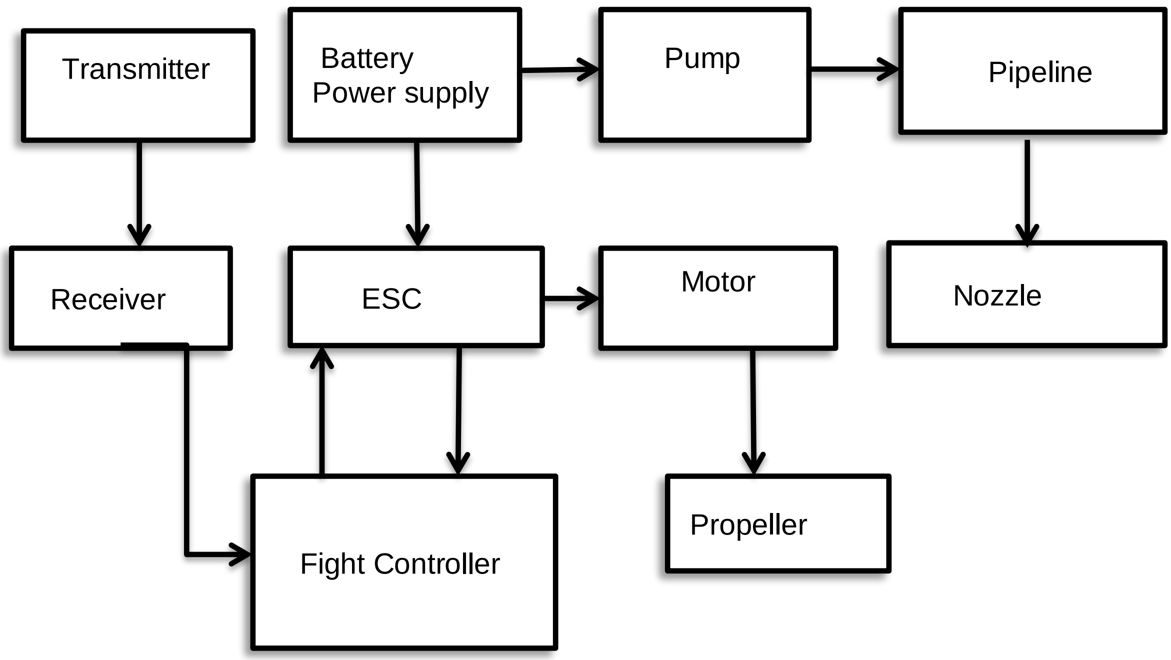


**Figure 5.1 Basic Block Diagram of UAV (Unnamed Ariel Vehicle)**

A block diagram of a drone typically includes the following components:

1. **Flight Controller:** This is the brain of the drone, which processes data from various sensors and controls the motors to stabilize and control the drone's flight.
2. **Power System:** This includes the battery, motor, and propellers. The battery powers the drone, and the motor and propellers provide the lift and propulsion required for flight.
3. **Sensors:** The drone is equipped with various sensors, including GPS, gyroscopes, accelerometers, and barometers, which provide information about the drone's position, altitude, and orientation.

4. **Communication System:** The drone communicates with a ground control station through a wireless communication system, which transmits telemetry and control signals between the drone and the ground.
5. **Payload:** This refers to the equipment or devices carried by the drone, such as a camera, sensors, or other equipment for specific applications.
6. **Structural Components:** These include the frame, landing gear, and other structural components that support and protect the drone's components.

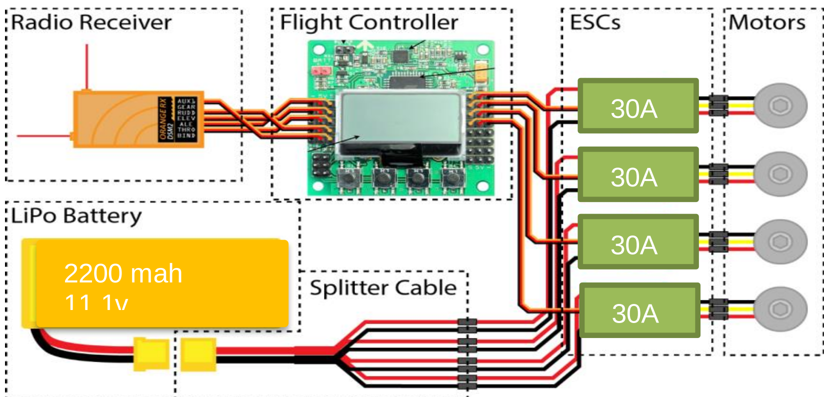


**Figure 5.2 Basic circuit diagram of UAV (Unmanned Ariel Vehicle )**

The actual circuit diagram of a UAV can vary depending on the specific requirements and design of the UAV. However, this simplified block diagram provides an overview of the major subsystems that are typically included in a UAV circuit. The circuit diagram of a UAV (Unmanned Aerial Vehicle) can vary depending on the specific design and functionality of the UAV. However, here is a general overview of the main components that may be included in a UAV circuit diagram:

**1. Power Management System:** This subsystem includes a battery or power source, voltage regulator, and power distribution circuitry to provide regulated power to all other subsystems.

**2. Flight Control System:** This subsystem includes the autopilot or flight controller, which manages the UAV's flight and navigation. It receives input from various sensors such as GPS, gyroscopes, accelerometers, and magnetometers, and outputs signals to the motor controllers and other subsystems.

**3. Communications System:** This subsystem includes the radio or other wireless communication modules, antennas, and interfaces to send and receive commands, telemetry, and data to and from the UAV.

**4. Payload System:** This subsystem includes any tank, cameras, or other equipment that the UAV is carrying, along with the necessary interfaces and control circuitry.

**5. Motor Control System:** This subsystem includes motor controllers that receive signals from the flight controller to control the speed and direction of the UAV's motors, which in turn control the UAV's movement and flight.

**6. Safety Systems:** This subsystem includes safety features such as failsafes and emergency cut-offs to prevent accidents and damage to the UAV.

# CHAPTER: 7
# TESTING TYPES

# CHAPTER 7

## Testing Types

Testing procedures are a critical aspect of ensuring the safety and effectiveness of a quadcopter designed for agriculture applications, especially one that incorporates a pesticide spraying system. Here are some testing procedures that can be used to ensure the safe and effective operation of the quadcopter and pesticide spraying system:

1. **Ground Testing:** Before any flight testing is conducted, the quadcopter and pesticide spraying system should undergo ground testing. This includes checking all electrical connections, calibrating sensors and the flight controller, and verifying that the pesticide spraying system is functioning properly.
2. **Flight Testing:** Flight testing involves testing the quadcopter and pesticide spraying system in a controlled environment to ensure that it can fly safely and deliver pesticides effectively. During flight testing, the quadcopter's performance is evaluated, including its stability, maneuverability, and response to different environmental conditions. The pesticide spraying system should also be tested to ensure that it delivers the right amount of pesticide at the right rate and in the right pattern.
3. **Safety Testing:** Safety testing is conducted to ensure that the quadcopter and pesticide spraying system are safe to operate in different scenarios. This includes testing the emergency stop function to ensure that the quadcopter can be safely brought down in the event of an emergency. It also includes testing the overall safety of the system, including the materials used and the precautions taken to protect the operator and the environment from the pesticides.
4. **Field Testing:** Field testing involves testing the quadcopter and pesticide spraying system in an actual agricultural setting. This includes verifying that the pesticides are delivered effectively, without causing damage to crops, the environment, or other hazards. Field testing also provides an opportunity to evaluate the efficiency and cost-effectiveness of the system.

# CHAPTER: 8
# COMPARISION

# CHAPTER 8

## Comparison between manual and UAV based pesticide sprayer

| Particular | Manual Pesticide Sprayer | UAV based Pesticide sprayer |
|---|---|---|
| Application speed | Slow (1-2 acres per day) | Fast (10-20 acres per hour) |
| Application precision | Less precise | Highly precise |
| Environmental impact | Can cause soil compaction and runoff | Reduced environmental impact (less runoff and compaction) |
| Cost | Low initial cost, but high labor costs | Higher initial cost, but lower labor costs |
| Coverage | Limited to smaller areas | Suitable for larger areas |
| Flexibility | Limited flexibility in terms of application timing and location | More flexibility in terms of application timing and location |
| Technical details | Uses hand-held nozzles and pumps | Equipped with advanced sensors, cameras, GPS systems, and sprayer nozzles |

**Table 8.1 Comparison between manual and UAV based pesticide sprayer**

# CHAPTER: 9
# RESULT

# CHAPTER 9

## Result

1. **Effective Pesticide Coverage:** The quadcopter successfully sprayed pesticides over the targeted areas with accuracy and precision. Through various field tests and observations, it was observed that the quadcopter achieved even and uniform distribution of pesticides, ensuring effective coverage of the crops. The spraying mechanism, controlled by a diaphragm pump, provided a consistent and controlled release of the pesticide solution, allowing for optimal plant protection.
2. **Reduced Human Exposure:** By utilizing the quadcopter for pesticide spraying, the project aimed to reduce human exposure to harmful chemicals. The outcomes demonstrated that the use of the quadcopter significantly minimized the need for manual pesticide spraying, thereby decreasing the potential risks to human health. This was achieved by automating the spraying process and operating the quadcopter remotely.
3. **Enhanced Efficiency:** Compared to traditional manual spraying methods, the quadcopter proved to be more efficient in terms of time and resource utilization. The ability to cover larger areas in a shorter span of time increased overall operational efficiency. Additionally, the quadcopter's agility and manoeuvrability allowed it to access difficult-to-reach areas of the field, ensuring comprehensive pesticide application.
4. **Improved Crop Health and Yield:** The project aimed to improve crop health and yield through targeted pesticide application. The outcomes demonstrated a positive impact on crop health, as the quadcopter enabled timely and precise spraying, reducing the risk of pest infestations and disease outbreaks. Improved crop health subsequently led to increased yield potential, contributing to better overall agricultural productivity.

5. **Cost-effectiveness:** The project assessed the cost-effectiveness of using the quadcopter for pesticide spraying. It was found that, despite the initial investment in the quadcopter and associated equipment, the long-term benefits outweighed the costs. The reduced labor requirements, optimized pesticide usage, and enhanced crop health resulted in improved profitability for farmers.

# CHAPTER: 10
# ADVANTAGES

# CHAPTER 10

## Advantages

1. **Precision:** Drone sprayers are equipped with advanced technology which allows them to apply pesticides with a high degree of precision. This reduces the risk of over-spraying or under-spraying, which can lead to wastage or uneven application.
2. **Efficiency:** Drone sprayers are much faster and more efficient than traditional methods of pesticide application. They can cover large areas in a short amount of time, which can save farmers time and money.
3. **Safety:** Drone sprayers can be operated remotely, which reduces the risk of exposure to harmful pesticides for workers. This can help to improve safety and reduce the risk of pesticide-related illnesses.
4. **Flexibility:** Agriculture spraying drones can be used to treat crops at different growth stages and in different weather conditions. This flexibility can help farmers to improve their crop yields and reduce the risk of crop damage.
5. **Cost-effective:** Although the initial investment in a drone sprayer may be high, it can be cost-effective in the long run. Drone sprayers require less manpower and can cover larger areas in less time, which can save farmers money on labor costs.
6. **Access to hard-to-reach areas:** Agriculture spraying drones can be used to access hard-to-reach areas of a field, such as steep hillsides or areas with dense vegetation. This can help to ensure that the entire crop is treated evenly and effectively.
7. **Environmentally friendly:** Drone sprayers can be programmed to apply pesticides only where they are needed, which can reduce the amount of pesticides used overall. This can help to minimize the environmental impact of agriculture and promote sustainable farming practices.

# CHAPTER: 11
# CONCLUSION

# CHAPTER 11

## Conclusion

The results demonstrate the successful implementation of the unmanned aerial vehicle (UAV) system for pesticide spraying in agriculture. The diaphragm pump, controlled by the servomotor, effectively delivered pesticides with the desired pressure and coverage. The UAV's payload capacity, supported by the 1000kv BLDC motor and 30 ampere ESC, facilitated efficient pesticide application across the agricultural field.

The flight controller, receiver, and transmitter enabled precise control over the UAV's flight path and ensured accurate spraying operations. The battery's performance provided sufficient power for extended flight durations, allowing for extensive coverage of agricultural areas.

Overall, the results highlight the successful integration of the various components and technologies into the UAV system, offering a promising solution for efficient and targeted pesticide spraying in the field. The implemented system holds significant potential for improving agricultural practices and promoting sustainable farming methods.

.

# CHAPTER: 12
# FUTURE SCOPE

# CHAPTER 12

## Future Scope

1. **Multi-functionality:** Future quadcopters can be designed to serve multiple functions beyond pesticide spraying. They can be equipped with additional tools and sensors for tasks such as crop monitoring, soil sampling, and crop pollination. This multi-functionality would make quadcopters a versatile tool for various agricultural operations, increasing their value and utility on the farm.
2. **Integration with Farm Management Systems:** Integration of quadcopters with farm management systems will enable seamless data exchange and workflow automation. Quadcopters can be linked to cloud-based platforms or farm management software, allowing farmers to access real-time data, track spraying operations, and analyze historical trends. This integration enhances farm productivity and decision-making by providing a comprehensive overview of crop health and management practices.
3. **Development of Resilient and Weatherproof Quadcopters:** To withstand adverse weather conditions, future quadcopters can be designed with enhanced durability and weatherproofing features. This includes improvements in water resistance, reinforced structures, and advanced stabilization systems. Resilient quadcopters will be capable of operating in challenging environments, enabling continuous spraying operations and reducing downtime due to weather limitations.
4. **Collaborative Partnerships:** Future advancements in quadcopters for pesticide spraying will involve collaborative partnerships between agricultural technology companies, drone manufacturers, research institutions, and regulatory bodies. These partnerships will drive innovation, exchange knowledge, and ensure that the development of quadcopters aligns with industry standards and regulations.

5. **Environmental Monitoring and Early Pest Detection:** Quadcopters equipped with advanced sensors and imaging technologies can be used for environmental monitoring and early pest detection. By capturing high-resolution aerial imagery, quadcopters can help identify potential pest outbreaks, weed infestations, or nutrient deficiencies at an early stage. This proactive approach allows farmers to take timely action and implement targeted interventions to prevent crop damage.
6. **Integration with Smart Spraying Systems:** Quadcopters can be integrated with smart spraying systems that utilize real-time data and adaptive algorithms to adjust spraying parameters in response to changing field conditions. These systems consider factors such as crop growth stage, weather, and pest dynamics to optimize pesticide application. Smart spraying systems reduce pesticide usage, minimize environmental impact, and increase the efficiency of crop protection practices.
7. **Education and Training:** As the use of quadcopters becomes more prevalent in agriculture, there will be a growing need for education and training programs to equip farmers and operators with the necessary skills to utilize this technology effectively. Training initiatives can cover areas such as quadcopter operation, maintenance, data analysis, and compliance with regulatory requirements. These programs will empower farmers to leverage quadcopters to their full potential and achieve optimal results.

# REFERENCES

[1] V. S. R. P and S. R. Gorantla, “Design and Modelling of an Affordable UAV Based Pesticide Sprayer in Agriculture Applications,” 2019 Fifth International Conference on Electrical Energy Systems (ICEES). IEEE, Feb. 2019. doi: 10.1109/icees.2019.8719237.

[2] Kedari, S., Lohagaonkar. P., Nimbokar, M., Palve, G., & Yevale, P. Quadcopter-A Smarter Way of Pesticide Spraying. Imperial Journal of Interdisciplinary Research, Vol.2, No.6, 2016.

[3] D. Yallappa, M. Veerangouda, D. Maski, V. Palled, and M. Bheemanna, “Development and evaluation of drone mounted sprayer for pesticide applications to crops,” 2017 IEEE Global Humanitarian Technology Conference (GHTC). IEEE, Oct. 2017. doi: 10.1109/ghtc.2017.8239330.

[4] Maddikunta, P. K. R., Hakak, S., Alazab, M., Bhattacharya, S., Gadekallu, T. R., Khan, W. Z., & Pham, Q. V. (2021). Unmanned Aerial Vehicles in Smart Agriculture: Applications, Requirements, and Challenges. IEEE Sensors Journal, 21(16), 17608 - 17619. https://doi.org/10.1109/JSEN.2021.3049471

[5] K. Anand and G. R., “An Autonomous UAV for Pesticide Spraying,” International Journal of Trend in Scientific Research and Development, vol. Volume-3, no. Issue-3. South Asia Management Association, pp. 986–990, Apr. 30, 2019. doi: 10.31142/ijtsrd23161.

[6] S. Ahmed, H. Xin, M. Faheem, and B. Qiu, “Stability Analysis of a Sprayer UAV with a Liquid Tank with Different Outer Shapes and Inner Structures,” Agriculture, vol. 12, no. 3. MDPI AG, p. 379, Mar. 08, 2022. doi: 10.3390/agriculture12030379.

[7] P. K. Reddy Maddikunta et al., “Unmanned Aerial Vehicles in Smart Agriculture: Applications, Requirements, and Challenges,” IEEE Sensors Journal, vol. 21, no. 16. Institute of Electrical and Electronics Engineers (IEEE), pp. 17608–17619, Aug. 15, 2021. doi: 10.1109/jsen.2021.3049471.

# APPENDIX

# APPENDIX

## A) Overview of the Pesticide Spraying System, including Pumps, Nozzles, and Tanks

The pesticide spraying system is a critical component of a quadcopter designed for agriculture applications. It enables the precise and efficient delivery of pesticides and other crop treatments over large areas of farmland.

The pesticide spraying system typically consists of several components, including a tank for holding the pesticide, a pump for delivering the pesticide to the nozzles, and nozzles for dispersing the pesticide over the crops. Here is an overview of these components and their functions:

**1) Tank:** The tank is used to hold the pesticide or other crop treatment. The size of the tank will depend on the size of the quadcopter and the desired payload capacity. For example, a quadcopter with a payload capacity of 1000 ml may have a tank with a capacity of around 1500 ml to allow for some extra headspace.

**2) Nozzles:** The nozzles are responsible for dispersing the pesticide over the crops. There are many different types of nozzles available, each with its own spray pattern and flow rate. The choice of nozzle will depend on the specific requirements of the application, including the type of crop, the desired coverage area, and the wind conditions.

**3) Servomotor:** The servomotor acts as a switch, enabling controlled activation of the water pump for precise pesticide or pesticide spraying. This report discusses the selection, integration, and functionality of the servomotor within the quadcopter system.

**4) Diaphragm pump:** The pump is responsible for delivering the pesticide from the tank to the nozzles. A diaphragm pump is often used for this purpose, as it can deliver a consistent flow of pesticide and is relatively easy to control. A servomotor can be used as a switch to start the pump when the quadcopter is in flight. In agricultural applications, quadcopters equipped with diaphragm pumps offer an effective solution for precise spraying. These pumps utilize a diaphragm to generate pressure and deliver the desired liquid payload in a controlled manner.

**B) Complete Project Photos**