GREEN AERIAL SOLUTION

BACHELOR OF TECHNOLOGY

IN

ELECTRONICS AND COMMUNICATION ENGINEERING

By

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UNDER THE GUIDANCE OF

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DECLARATION

We hereby declare that the work reported in the B.Tech Project Report entitled **"Green Aerial Solutions"** submitted at **Jaypee University of Information Technology, Waknaghat, India** is an authentic record of our work carried out under the supervision of **Dr. Vikas Baghel.** We have not submitted this work elsewhere for any other degree or diploma.

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled "Green Aerial Solutions" in partial fulfilment of the requirements for the award of the degree of B.Tech in Electronics and Communication Engineering and Submitted to the Department of Electronics and Communication Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by "**Rahul Rana, 201024**" and "**Aryan Bharadwaj, 201182**"

During the period from August 2023 to May 2024 under the supervision of **Dr. Vikas Baghel,** Department of Electronics and Communication Engineering, Jaypee University of Information Technology, Waknaghat

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Full Form
APM	ArduPilot Mega
ADC	Analog to Digital Converter
AI	Artificial Intelligence
AWG	American Wire Gauge
BEC	Battery Eliminator Circuit
BLDC	Brushless Direct Current
CCW	Counter-Clockwise
CEP	Circular Error Probable
CW	Clockwise
DSM	Digital Spectrum Modulation
ESC	Electronic Speed Controller
FPU	Floating Point Unit
FPGA	Field Programmable Gate Array
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HW	Hardware
IoT	Internet of Things
JST	Japan Solderless Terminal
KV	RPM per Volt
LNA	Low Noise Amplifier
LiPo	Lithium Polymer
MAVLink	Micro Air Vehicle Link
ML	Machine Learning
PCB	Printed Circuit Board
PPM	Pulse Position Modulation
PWM	Pulse Width Modulation
QZSS	Quasi-Zenith Satellite System
RAM	Random Access Memory
RF	Radio Frequency
RPM	Revolutions Per Minute
RSSI	Received Signal Strength Indicator
SBAS	Satellite Based Augmentation System
SPI	Serial Peripheral Interface
TCXO	Temperature Compensated Crystal Oscillator
TDM	Time Division Multiplexing

UAV	Unmanned Aerial Vehicle
UART	Universal Asynchronous Receiver/Transmitter

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ABSTRACT

The application of unmanned aerial vehicles, or drones, is bringing agriculture, a pillar of human civilization, back to life technologically. The revolutionary effect of agricultural drones in contemporary farming practices is examined in this abstract. With their sophisticated sensors, cameras, and data analytics capabilities, these drones provide farmers previously unheard-of insights into the management of their farms—including their crops, soil, and general operations.

Improving precision agriculture is the main goal of agricultural drones. Drones use high-resolution imaging technologies to help farmers monitor crop health, identify nutritional deficits, and detect illnesses with amazing accuracy. The information gathered helps to optimise the distribution of resources, improving yields and lessening the impact on the environment.

Furthermore, the use of machine learning (ML) and artificial intelligence (AI) algorithms enables drones to examine enormous dataset autonomously. Farmers' decision-making process is streamlined as a result, and predictive modelling for crop yields, pest outbreaks, and climate-related effects is made easier.

Drones used in agriculture are not limited to crop surveillance. They aid in the creation of thorough field maps that enable farmers to evaluate drainage patterns, topography, and soil conditions. This information helps to reduce the dangers associated with different terrains, optimise planting plans, and manage land more effectively.

The abstract also explores the possibilities of drone swarms, which are organised groups of drones that collaborate to cover large areas of agriculture. With the help of this technology, data collecting and monitoring processes should become much more efficient, giving farmers a comprehensive understanding of their areas.

Drone technology for agriculture may advance to include features like enhanced autonomy, customizable modular designs, and increased energy efficiency. Drones are also anticipated to be crucial in the supply of agricultural inputs, guaranteeing accurate application and resource optimisation.

Global networking, environmental monitoring, and legal frameworks must all be taken into account as agricultural drone technology advances. Achieving equilibrium between inventiveness and conscientious application will be essential for fully using agricultural drones for sustainable and effective farming methods.

This abstract concludes by highlighting the various ways that drones have improved the agricultural landscape and highlighting how they have the ability to completely change how farmers manage their crops, allocate resources, and take care of the environment

CHAPTER 1 :- INTRODUCTION

1.1 **What are drone?**

- Unmanned aerial vehicle (UAV) commonly known as drone is a vehicle without any pilot on board or any human. These kind of vehicles are either control by humans remotely or they are automatic. They have a system of communication in them.
- UAV's were invented for the military purposes in twentieth century.
- They can carry lethal and non-lethal payload.
- With advancement in technology cost fell and due to it UAV'S are used for many non military purposes now a days, like for photography, surveillance, agriculture, smuggling, product deliveries and many more.

1.1.1 Criterias on which drones are classified

WEIGHT – By weight drones have 5 categories

1. Nano (upto 250g) 4. Medium (25 – 150 kg)
2. Micro air vehicles (250 g – 2 kg) 5. Large (over 150 kg)
3. Miniature UAV or small (SUAV) (2 – 25 kg

Degree of autonomy –

UAVs are either remotely controlled/ piloted or fully autonomous(automatic). Some UAVs offers intermediate degrees of autonomy like some UAVs may be initially piloted manually but they can be put in autopilot mode also.

Altitude –

1. Hand-held – 2000 ft altitude , 2km range.
2. Close – 5000 ft altitude, 10 km range.
3. NATO 10,000 ft altitude, 50 km range.
4. Tactical 18,000 ft altitude, 160km range.
5. MALE (medium altitude, long endurance) upto 30,000ft altitude, 200km range.
6. HALE (high altitude, long endurance) over 30,000 ft altitude and indefinite range.

7.Hypersonic high-speed, supersonic or hypersonic 50,000ft or suborbital altitude, range is over 200km.

8. Orbital low earth orbit.
9. CIS Lunar Earth- Moon transfer.

10. Computer Assisted Carrier Guidance System for UAVs.

-COMPOSITE CRITERIA

Composite criteria means the criteria formed by combining several performances metrics in order to better the performance. Eg, U.S. Military's Unmanned aerial systems classifications of UAVs based on weight , maximum altitude and speed of the UAV component.

1.1.2 Types of Drones

There are majorly two main types of drone :-

1 Rotor Drones , single-rotor and multi-rotor, such as tri-copters, quadcopters, hexa-copters and octocopters.

2 Fixed-wing, which include the hybrid vertical takeoff and landing (VTOL) drones that don't require runways.

A multi-copter becomes a UAV or Drone when it is capable of autonomous flight. Normally this means taking the accelerometer and gyro information and combining it with barometer and GPS data so the flight controller understands not only its orientation but also its position.

Applications

1Still and Video Photography

2. First Person View (FPV)

3. Disaster response

4. Search (and rescue)

5. Agricultural applications

6. Forest fire mitigation

7. Hazard/danger mitigation

8. 3D Mapping and GIS (Geographic Information Systems)

9. Inspection, Verification and Sample Collection

10. Payload Based Applications

1.2 Objective

Develop a modern crop spraying solution using drone technology.
Address the limitations of traditional crop spraying methods in India.
Enhance crop yield and quality through precise and efficient spraying.
Minimize health risks for farmworkers associated with manual pesticide application.

1.3 Motivation

Addressing Farming Challenges: Modern agriculture faces challenges related to manual pesticide spraying, crop damage, and labor-intensive tasks.
Precision and Efficiency: Manual methods lack precision and consume considerable time and effort.
Crop Health and Productivity: Enhancing crop health and overall productivity is crucial for agricultural sustainability.

1.4 Future Scope

In this our future work could be that we can use ML applications to detect disease of insects on the plants and time by time we can keep eye on the health of our crop.

By collecting crop photos in both the infrared and visible spectral ranges, drone can extract various features that are not visible to the naked eyes, offer insight to the health of plants.

The regular availibility of such crop information allow farmers to make necessary adjustments and improve crop management strategies.

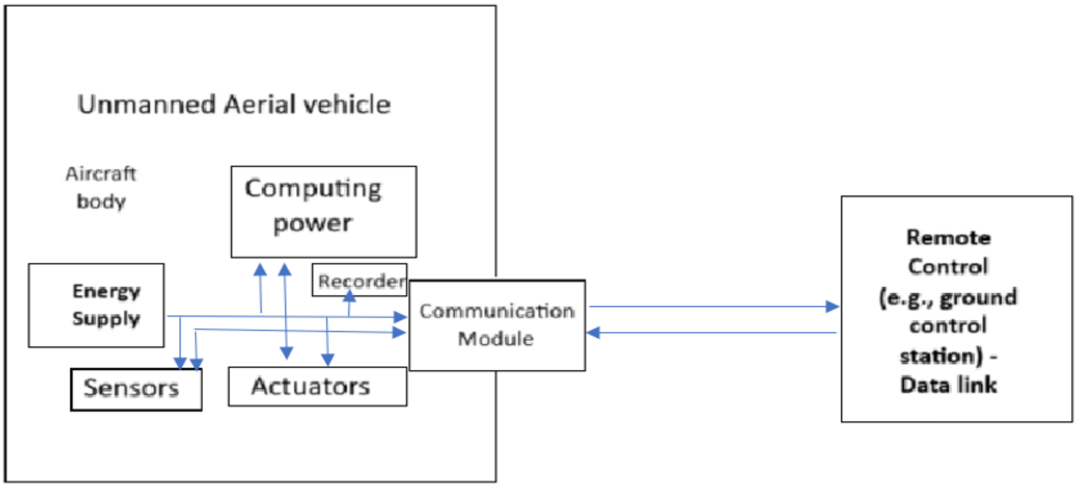


Fig. 1.1 Physical structure of an UAV

CHAPTER 2:- AGRICULTURE DRONE

2.1 Brief introduction of drone in agriculture :-

The COVID-19 pandemic significantly impacted the networks that produce crops and deliver food. Many farmers did not have timely access to essential agricultural necessities like labor, seeds, fertilizer, and pesticides, which reduced their output.

Many developing Asian countries are struggling with issues including a large population and considerably poorer agrarian productivity when compared to more developed countries in terms of technology. India also has a similar problem. Almost 73% of Indians are either directly or indirectly reliant on the agricultural sector.

Drones have numerous benefits in agriculture, and they are driving the advancement of precision farming. Analysts predict that the value of drones in agriculture will reach a staggering $5 billion by 2025. Farmers and agronomists can use drones to assess the health of their crops quickly and efficiently.

With drones, they can obtain a comprehensive overview of their fields and gather data much faster than traditional methods. By leveraging drone technology, farmers can monitor the health of their crops, identify areas that require water or nutrients, and detect pest activity before it becomes a significant problem.

2.2 Brief about our project:-

Our project offers a comprehensive approach to crop protection that utilizes advanced spraying systems. Drones offer improved efficiency, accuracy, and cost savings for farmers by identifying potential problems that may have otherwise gone unnoticed.

With this drone, farmers can take timely action to prevent losses in crop yields. The innovative aspect of this project is the utilization of a spraying system in a affordable price.In hexacopters, which enables farmers to spray pesticides with great precision and effectiveness over a wider area.

Overall, the use of drones in agriculture is a game-changer that allows farmers to maximize their yields and protect their profits.

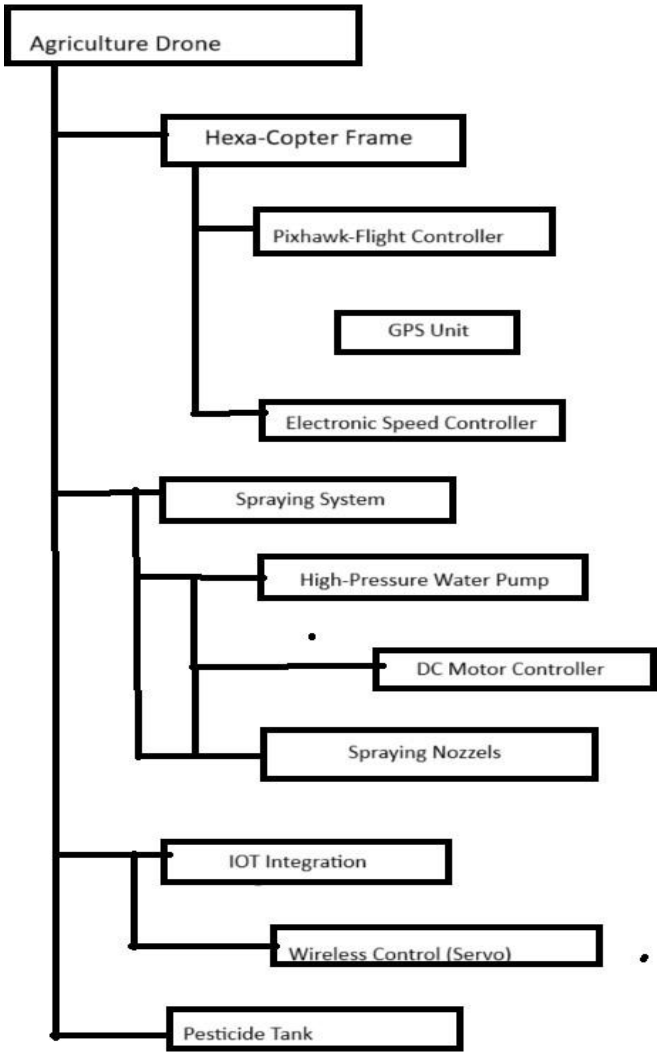


Fig.2.1 Blocks in Drone

CHAPTER 3 :- NATURE OF INNOVATION

As the population continues to grow, the demand for food is increasing rapidly, making our country highly dependent on agriculture. Not only does agriculture provide food, but it also offers employment opportunities. However, farmers face numerous challenges every day.

i. It is very tedious for farmers to manually inspect every crop one by one and identify whether the plant is diseased or requires any pesticides. After detecting any problem in the plant, farmers have to spray the pesticide manually which is very time-consuming.

ii. Spraying pesticides manually can pose significant health risks, such as accidental exposure to the sprayer's eyes or inhalation, leading to skin burns, irritation, and other health issues. While spraying on big trees often results in wastage as it is difficult to effectively cover the entire tree manually.

iii. The act of walking through the field to manually spray pesticides can also cause damage to the plants, as well as the potential for improper application due to using conventional machines with incorrect pressure settings.

Additionally, the use of conventional machines often requires the consumption of either fuel or petrol, leading to increased costs and environmental impact. Agricultural drones offer a solution to these problems by providing a more precise, automated, and safer method of pesticide application.

The proposal to design an agricultural drone is aimed at addressing these challenges and providing farmers with a better alternative for pest control.

3.1 Application of drone in agriculture:-

The use of drones in agriculture enables farmers to obtain aerial views of their harvest, providing details on crop health and pesticide application. For a spraying system, extendable and rotatable arms will be designed which will be embedded in a hexacopter.

In this project, we have indigenously design a device that helps in spraying with minimal capacity of pesticides.

Numerous UAVs have been designed to address the challenges faced by farmers, and we aim to contribute to this area by developing an IoT-enabled agricultural drone that minimizes the need for manual labor.

3.2 About our working of drone:-

In the face of growing global food demands and the need for sustainable farming practices, technological innovations in agriculture are more critical than ever. Our drone is equipped with a sophisticated spraying system and remote control capabilities, this drone is designed to increase efficiency, reduce labour costs, and enhance overall productivity for farmers.

Increase Efficiency: The drone minimizes the time and effort required to apply pesticides and fertilizers.

Reduce Labor Costs: The drone reduces the need for manual labor, allowing farmers to allocate resources more effectively.

Enhance Productivity: Precise and targeted spraying improves crop health and yields, leading to higher productivity.

Micro and Macro Droplet Spraying: The drone is capable of dispensing both micro and macro droplets (But nozzels needs to be selected as per requirements) . Micro-droplets ensure a fine mist for delicate plants and precise applications, while macro-droplets cover larger areas quickly and efficiently.

Multi-directional Spraying: The system allows for spraying in all necessary directions, ensuring comprehensive coverage and better pest control.

Remote Operation: Farmers can control the drone remotely, reducing the need for physical presence in the field. This feature is particularly beneficial for large farms and areas with difficult terrain.

Resource Efficiency: Precise application of pesticides and fertilizers minimizes waste and reduces the environmental impact of farming practices.

Cost Savings: Lower labor costs and reduced expenditure on chemicals translate into significant cost savings for farmers.

Increased Yields: Healthier crops and efficient pest control contribute to higher yields and improved food production.

The advanced agricultural hexacopter drone represents a significant step forward in precision agriculture. By integrating cutting-edge technology with practical farming applications, this drone has the potential to transform farming practices, making them more efficient, cost-effective, and sustainable. Through continued innovation and development, we aim to support farmers in their efforts to meet global food demands while preserving environmental health

CHAPTER 4 :- HEXACOPTER MOVEMENTS

4.1 Hexacopter movement mechanism

A hexacopter is an aircraft designed with a hexagonal frame, featuring six rotors, each equipped with a propeller controlled by an electronic speed controller (ESC). The aircraft's movement is managed by adjusting the rotational speeds of these fixed-pitch rotors. By varying the revolutions per minute (RPM) of the individual rotors, the hexacopter can effectively control its roll, pitch, and yaw, allowing for precise maneuvering.

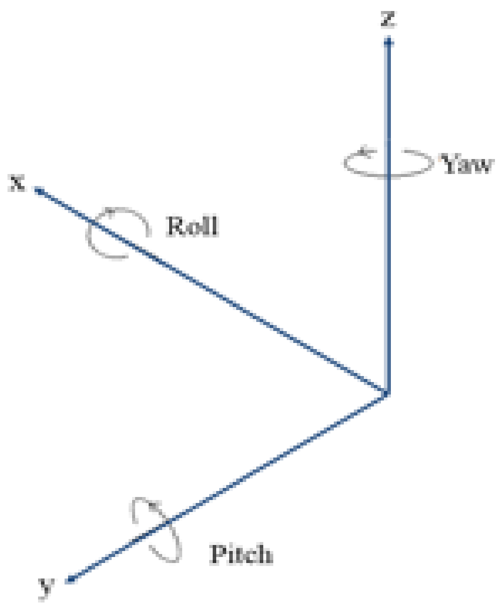


Fig.4.1 Movements w.r.t. Coordinates

Essentially, the thrust generated by each of the six propellers connected to the hexacopter's rotors acts as one of its six force inputs. By adjusting this thrust, the motion of the hexacopter can be precisely managed. Control over the hexacopter's movement is achieved by varying the speed of each rotor, which in turn regulates the thrust produced by each propeller.

The hexacopter achieves different movements by adjusting the speeds of its six motors, each influencing the thrust generated by its corresponding propeller. Take-off and landing mechanism, forward and backward motion, left and right motion, hovering each of these maneuvers relies on the intricate coordination of motor speeds to control the hexacopter's orientation and movement.

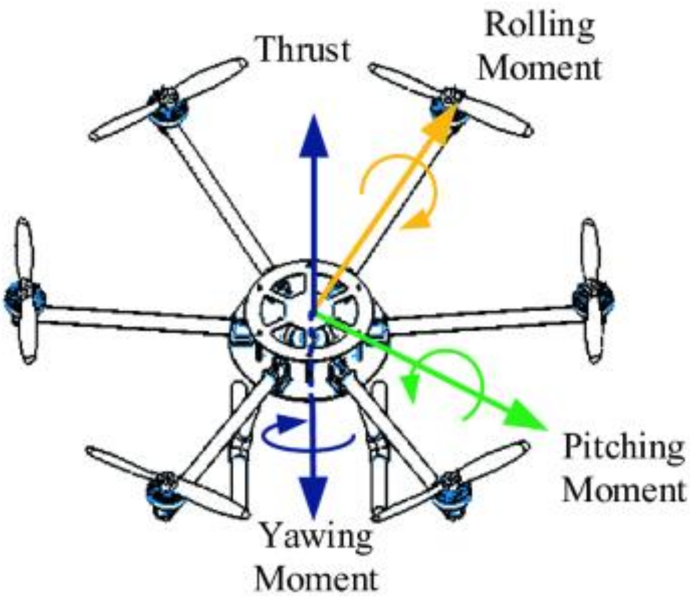


Fig.4.2 Roll, Pitch, Yaw

- **Movements**

The hexacopter achieves different movements by adjusting the speeds of its six rotors, which in turn controls the thrust produced by each propeller. Here's a detailed explanation of each type of movement:

1. **Forward and Backward Motion:** To move forward, the rotors at the rear of the hexacopter spin faster, generating more thrust and tilting the hexacopter forward. This tilt propels it in the forward direction. For backward motion, the front rotors spin faster, tilting the hexacopter backward and moving it in the reverse direction.

2. **Left and Right Motion:** Lateral movement is achieved by adjusting the speeds of the rotors on one side of the hexacopter. To move left, the rotors on the right side spin faster, causing the hexacopter to tilt left and move in that direction. To move right, the rotors on the left side increase their speeds, tilting the hexacopter right.

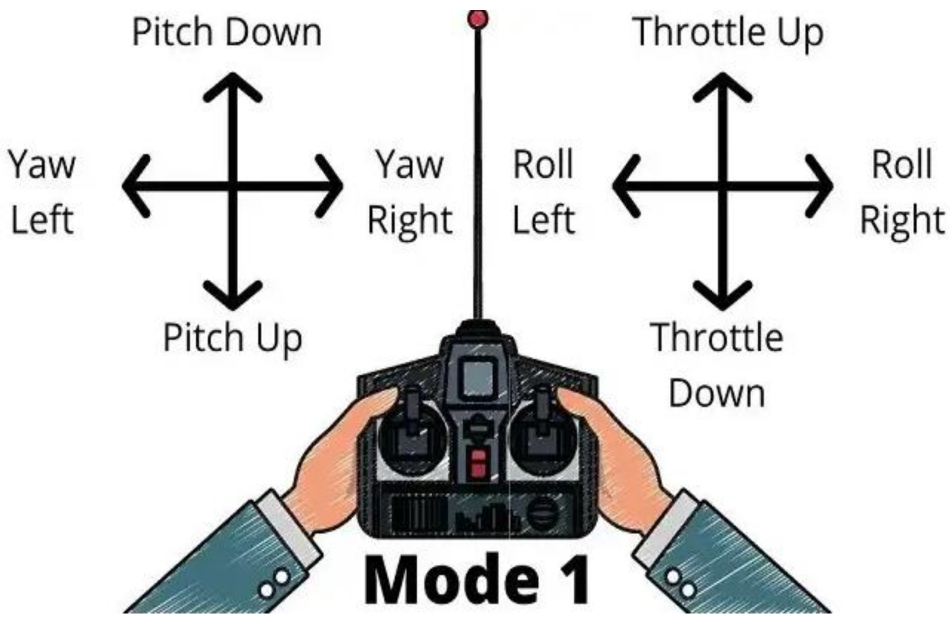
3. **Take-off and Landing:** For take-off, all six rotors increase their speeds simultaneously, generating sufficient thrust to lift the hexacopter off the ground. Conversely, for landing, all rotors decrease their speeds in unison, reducing thrust and allowing the hexacopter to descend gently.

4. **Hovering:** To hover, the hexacopter must maintain a precise balance of rotor speeds. Each rotor must generate just enough thrust to counteract gravity, keeping the hexacopter stable and at a constant altitude without drifting in any direction.

5. **Yaw (Rotational Movement): Yaw** is controlled by varying the speeds of rotors spinning in opposite directions. By speeding up the rotors that spin clockwise and slowing down those that spin counterclockwise (or vice versa), the hexacopter can rotate around its vertical axis, changing its orientation without altering its position.

Each of these movements relies on the precise coordination of rotor speeds, allowing the hexacopter to maneuver accurately and efficiently in three-dimensional space.

Fig 4.3 Controls from transmitter



CHAPTER 5:-WORKDONE IN PROJECT

5.1 Workdone

The development of our advanced spraying system for the hexacopter drone involves a series of precise integrations and configurations to ensure optimal performance. This system starts with the attachment of spraying nozzles to a high-pressure water pump using a network of pipes securely mounted on a plate. This setup enables the nozzles to effectively lift and direct the spray as needed, ensuring comprehensive coverage.

The water pump, operating with a 9-14V power supply and capable of delivering 110 psi of pressure, is a critical component. It is equipped with both inlet and outlet connectors to facilitate seamless fluid flow. To control this pump, we employ a DC voltage controller that includes a potentiometer for fine-tuning. Wireless control is achieved through a servo motor, which allows remote adjustments to the brushless motor's speed. This motor is firmly attached to the drone's frame, with its outlet directly connected to the spraying nozzle, ensuring precise delivery of the pesticide.

Fig.5.1. Water Dispersion System

The integration process involves modifying the motor pump's wires to connect them to the controller's output, ensuring seamless and efficient operation. A pesticide tank is integrated into the drone's design, connected to the motor to provide a steady supply of pesticide to the spraying system. This configuration allows for efficient and controlled spraying, crucial for agricultural applications.

For the drone's navigation and control, we utilized a Pixhawk flight controller, known for its reliability and advanced capabilities. The setup began by connecting the power module pin to its designated port on the Pixhawk, ensuring a stable power supply. The safety switch pin was also secured in its respective location to enable emergency shutoff capabilities.

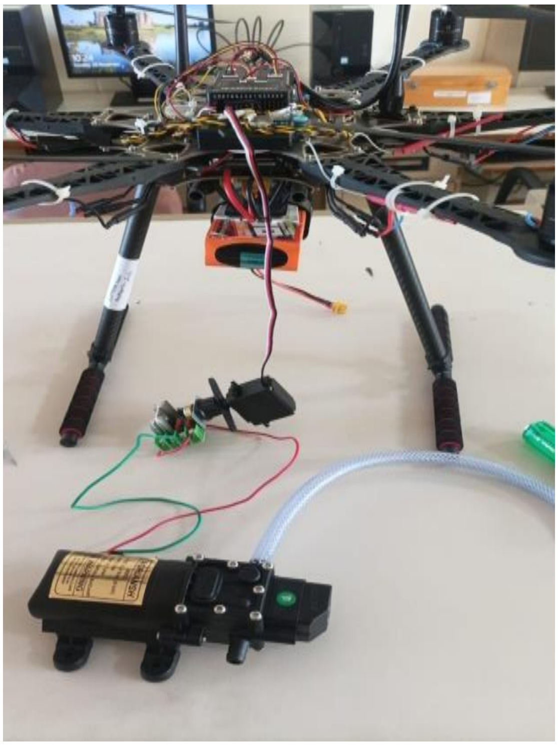


Fig.5.2. Water Pump Connected to Hexa-Copter

The motor connections were established through the Electronic Speed Controller (ESC), which regulates the speed and performance of the rotors. Receiver pins were connected to the RC input, enabling manual control of the drone. Additionally, a GPS unit was connected to the GPS port on the ESC, providing accurate positioning and navigation data.

By meticulously assembling these components, we have developed a highly functional hexacopter drone equipped with an efficient and controllable spraying system. This drone is now capable of performing precise and targeted spraying operations, making it an invaluable tool for modern agricultural practices. The integration of advanced control systems and robust hardware ensures that the drone can operate reliably in various conditions, providing a powerful solution for pest control and crop management.

5.2 Connections and Assembly

1.Assemble the frame with the standing gear with proper screws, put gimble uder the spider-base.

2. Solder the ESCs (Red wire +ve , Black wire -ve) properly and power module also.

3. To save space and for the safety of ESCs place them under the upper spider base.

4. Fix the motors by referring the proper anatomy of your frame type.

5.Connect the ESC and the motors, connect three wires in series. If the motors will be rotating in the opposite direction as excepted then switch the outer two wires don't change the black wire the middle one.

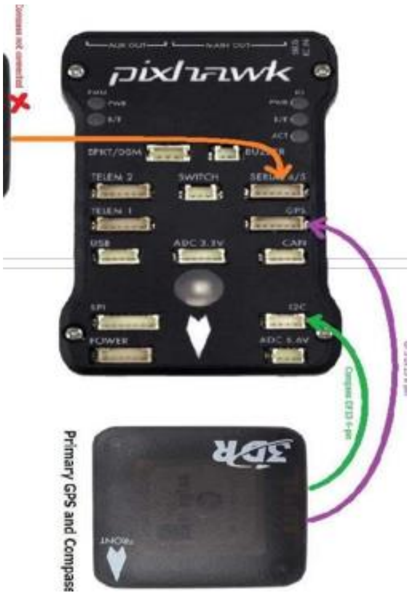


Fig.5.3. Flight Controller

6.Mount the shock absorber plate on the upper spider base. And fix the flight controller on it with the help of double tapes.

7.Assemble the GPS stand and fix it above all the peripherals, as to avoid interference.

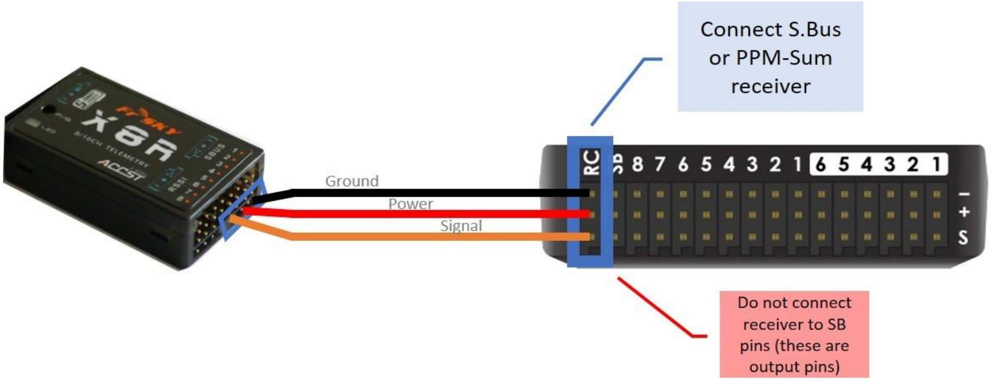


Fig. 5.4 Receiver Connection with Flight Controller

8.Connect all the peripherals like Buzzer, GPS, Safety Switch , Telemetry, ESCs, receiver and Arduino to the Flight Controller.

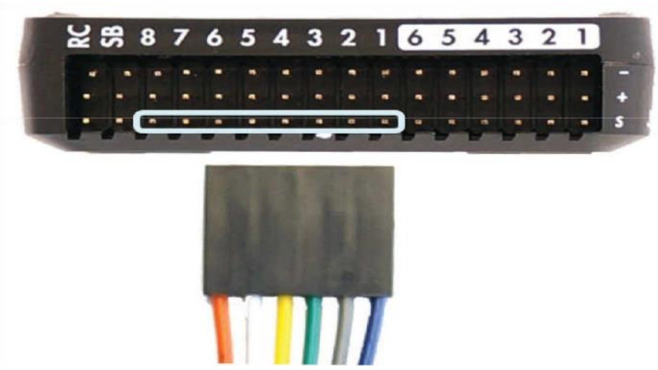


Fig.5.5 ESCs signal Bus and signal wires

9.Give power by power module to the flight controller.

10..After it you can do calibration and set necessary parameters by connecting Mavlink to ArduPilot.

11.Connect the correct propellors to the motors. (Refer diagram)

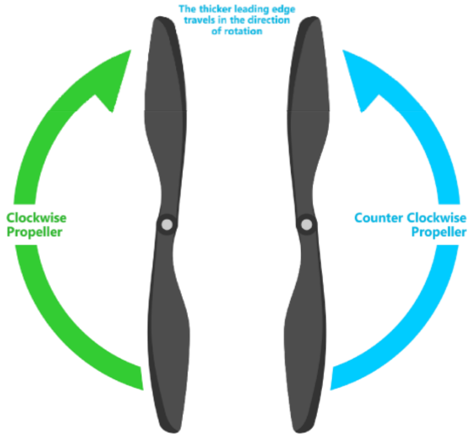


Fig.5.6 Propellors CW and CCW motors.

12. Agriansh 110 psi water motor pump is connected with manual dc esc made with help of servo motor and voltage regulator
13. Servo motor is calibrated with transmitter and is controlled remotely
14. Drone is ready to fly.

5.3 Block Diagram:-

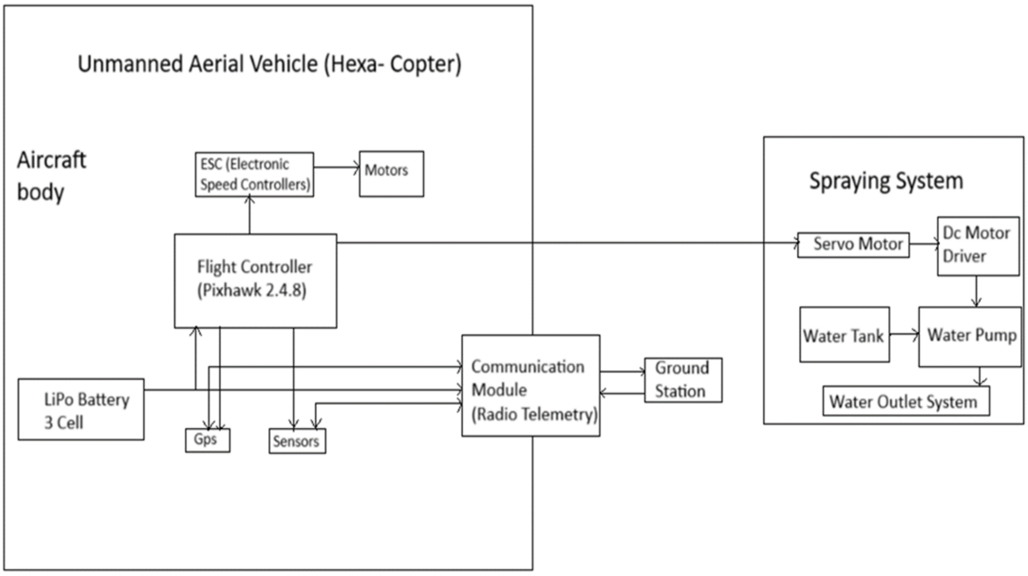


Fig.5.7. Block Diagram

CHAPTER 6:- DESIGN AND SPECIFICATION OF PROJECT

DESIGN

6.1 Initial 3D Design :-

(Created Using Solid-Works)

Fig. 6.1 Side View

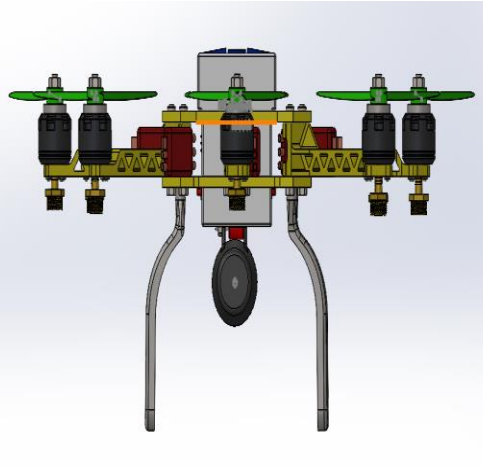


Fig. 6.2 Front View

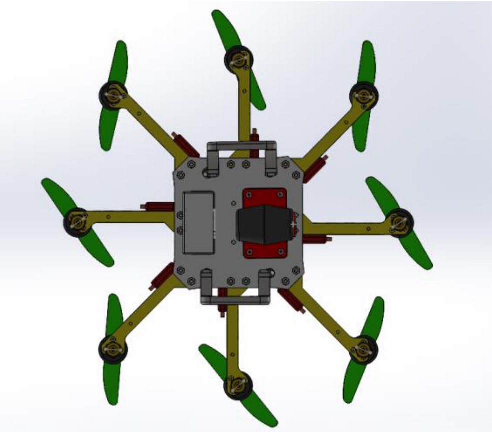


Fig. 6.3 Bottom View

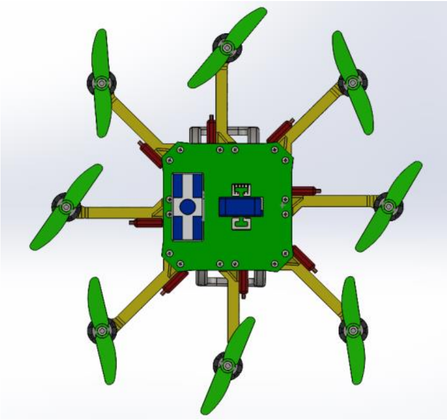


Fig. 6.4Top View

6.2 Hardware Design:-

Fig.6.5 UAV

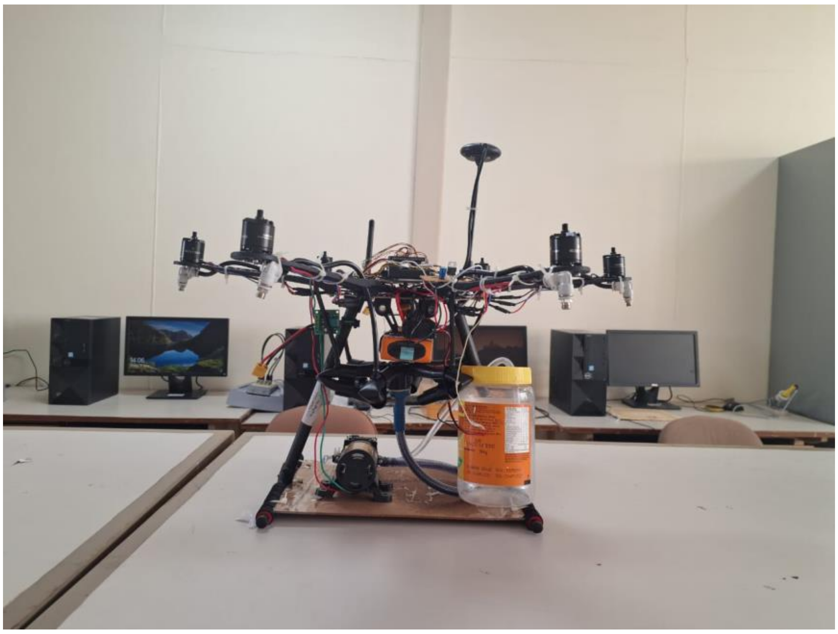


Fig.6.6 UAV mounted with Spraying System

6.3 Parts and specifications (3D Design) :-

BLDC motor	Motors 500rpm Base and top length*width 102mm Length 0.94inch Length of motor pin for fan is 0.14inch Motor pin radius is 0.04 inch Angle cutouts 45deg Upper cutouts length 0.11inch Lower pin that is being attached to arm radius 0.04inch
HEX NUTS	lengths = 3mm to 20mm
SPIDER BASE	4.02 BY 4.02 INCH made of medium gloss plastic
SPIDER TOP	4.02 by 4.02 inch made of medium gloss plastic have 16 holes each of 0.12inch
SPIDER BASE	have 16 holes each of 0.12inch
POWER DISTRIBUTION STAND	unit is 2.28 *2.28 inch it have four holes diameter of holes is 0.12 inch
POWER DISTRIBUTION UNIT	1.42 * 1.42 inch Distance between holes us 1.20 inch Diameter of holes 0.12 inch
USB SLOT	Length is0.12inch width is 0.07 inch

ARMS	made of medium gloss plastic Distance between motor hole and base hole 3.23 inch Width from front face 0.71 inch Base holes and motor hole diameter is 0.12 inch Base holes for motor

	attachment diameter is 0.9ich Distance between base holes 0.47inch Width of arm from mid back face 0.35 inch Angles of cut out 45 deg
LOWER PIN	length 0.07inch
LOWER CUTOUT	Angles 45deg Lower cut outs length 0.08inch
LOWER PIN TO INNER CIRCLE AND UPPER PIN TO INNER CIRCLE	Distance 0.33
SPINNER	length 0.57inch Base radius 0.31 inch Base to top length 0.43inch Top radius 0.08inch
FAN	One side fan length 1.71inch Curves on blade diameter left 0.20 inch right 0.12 inch(vertical side) Blade connector diameter 0.45 inch It have inner diameter of 0.12inch
IRSENSOR	0.60*0.25inch length and with respect Led lengths 0.02inch both Diameter of led 0.01inch Led are emitter and receiver VCC ground and output pin are of same length 0.12inch width 0.01 inch Distance adjust length 0.07 by 0.07 inch

ELECTRICAL CONNECTOR	Length 0.94 inch width 0.71 inch Height 0.28inch Curves radius is 0.08inch Circular pins distance -0. 17inch Circular pin diameter 0.12 inch Reset pin length 0.18 by 0.06inch
BATTERY	Width 0.59 inch Length 1.31inch Curves cut radius 0.04inch
CAMERA	Length is 1.78inch Middle heap diameter 1.25inch Distance from core to gimble cut out 0.80inch Gimble cutouts diameter 0.12 inch
GIMBLE	Length 2.17inch Width 1.38inch
ULTRASONIC SENSOR	Height 0.12inch Circle cuto-ut diameter 0.12 inch
STAND	Distance between legs 2.17inch Lower leg thickness 0.26inch Upper curve thickness 0.20inch Upper curve angle 25deg Lower leg length from curve 2.36inch Connecting top diameter 0.28inch
WATER TANK SERVO MOTOR VOLTAGE CONTROLLER PLY BOARD	

Note:- The dimensions can be changed as per the requirement

6.4 Specifications of Final Drone :-

6.4.1 Pixhawk V2.4.8 Flight Board

Feature	Specification
Processor	32-bit STM32F427 Cortex M4 core with FPU, 168 MHz, 128 KB RAM, 2 MB Flash
Failsafe Co-processor	32-bit STM32F103
PWM/Servo Outputs	14
Bus Interfaces	UART, I2C, SPI, CAN
Power	Redundant power input, integrated backup power
Modes	Automatic and manual
Indicators	Multicolor LED lights, multi-tone buzzer interface
Data Recording	Micro SD card for flight data
UART Ports	5 (one high-power capable, 2 with HW flow control)
CAN Ports	2 (one with internal 3.3V transceiver)
Compatible Inputs	Spektrum DSM / DSM2 / DSM-X®, Futaba S.BUS®, PPM sum signal, RSSI (PWM or voltage)
Additional Interfaces	I2C, SPI, 3.3 and 6.6V ADC inputs, internal and external micro USB ports
Gyroscope	ST Micro L3GD20H 16 bit
Accelerometer/Magnetometer	ST Micro X4HBA 303H 14 bit
Additional Sensors	Invensense MPU 6000 3-axis accelerometer/gyroscope, MEAS MS5607 barometer

6.4.2 Glass Fiber Flight Controller Anti-vibration/Shock Absorber Set

Feature	Specification
Color	Black
Material	Glass fiber
Compatibility	APM 2.5/2.6/2.8, KK, MWC, Pixhawk 2.4
Package Weight	24 gm
Upper Frame Size	90 x 60 x 2 mm (LxWxH)
Lower Frame Size	100 x 70 x 2 mm (LxWxH)
Shock Absorber Height	10 x 12 mm (DxH)

6.4.3 NEO-M8N GPS Module

Feature	Specification
Receiver Type	72-channel Ublox M8 engine
Supported Systems	GPS/QZSS L1 C/A, GLONASS L10F, BeiDou B1
SBAS	L1 C/A: WAAS, EGNOS, MSAS
Galileo-ready	E1B/C (NEO-M8N)
Navigation Update Rate	Single GNSS: up to 18 Hz, Concurrent GNSS: up to 10 Hz
Position Accuracy	2.0 m CEP
Acquisition Times	Cold start: 26 s, Aided starts: 2 s, Reacquisition: 1.5 s
Sensitivity	Tracking & Nav: –167 dBm, Cold start: –148 dBm, Hot starts: –156 dBm
Assistance	AssistNow GNSS Online/Offline, AssistNow Autonomous, OMA SUPL & 3GPP compliant
Oscillator	TCXO (NEO-M8N/Q), Crystal (NEO-M8M)
Noise Figure	On-chip LNA, Extra LNA for lowest noise figure (NEO-M8N/Q)
Anti-jamming	Active CW detection and removal, Extra onboard SAW bandpass filter (NEO-M8N/Q)
Memory	ROM (NEO-M8M/Q) or Flash (NEO-M8N)
Supported Antennas	Active and passive
Additional Features	Odometer, Data-logger (NEO-M8N)

6.4.4 GPS Folding Base Antenna Set

Feature	Specification
Material	CNC Aluminum alloy, carbon glass fiber rod
Mounting Rod Diameter	4mm
Rod Length	14 cm
GPS Plate Diameter	40 mm
Base Plate Diameter	35 mm
Mounting Hole Spacing	16-35 mm
Weight	20 g
Color	Anodised black
Note	Adhesive Pad is not included

6.4.5APM 2.5.2/2.6/2.8 Pixhawk Power Module V1.0

Feature	Specification
Max Input Voltage	28V
Max Current Sensing	90A
Voltage/Current Measurement	Configured for 5V ADC
Regulator Output	5.3V, 3A max
Connector	6-pos DF13 cable plugs to APM 2.5's ‘PM’ connector
Battery Support	6S battery

6.4.6 433MHz Radio Telemetry

Feature	Specification
Size	Very small
Weight	Under 4 grams without antenna
Frequency	433MHz
Receiver Sensitivity	-121 dBm
Transmit Power	Up to 20dBm (100mW)
Serial Link	Transparent
Air Data Rates	Up to 250kbps
Range	Approx. 1 mile
Protocol	MAVLink
Frequency Hopping	FHSS
Time Division Multiplexing	Adaptive TDM
Duty Cycle	Configurable
Error Correction	Built-in, can correct up to 25% data bit errors
Demonstrated Range	Several kilometers with a small Omni antenna
Amplifier Compatibility	Bi-directional for extended range
Firmware	Open source
Radio Configuration	AT and RT commands
Flow Control	Adaptive, when used with APM
RF Module	HopeRF HM-TRP, SiLabs Si1000 RF microcontroller

6.4.7 Pixhawk PPM Encoder Module

Feature	Specification
Input Channels	8
Output	PPM SUM × 1 / MUX × 1
Dimensions	28 x 19 x 5 mm
Weight	12 gm (including all input and output wires)

6.4.8 Air20A ESC

Feature	Specification	Details
Max Continuous Current	20A	Provides stable power output
Burst Current	25A (up to 10 seconds)	Handles short-term overloads
Input Voltage	2-4S LiPo (7.4V - 14.8V)	Compatible with common LiPo batteries
BEC Output	5V, 3A	Powers onboard electronics
Weight	12g	Lightweight design
Dimensions	45 x 24 x 8 mm	Compact size for easy installation
Firmware	BLHeli	Popular firmware for performance tuning
Motor Compatibility	Compatible with most brushless motors	Versatile usage

6.4.9 T1045 Propeller (CW & CCW)

Feature	Specification	Details
Diameter	10 inches	Suitable for medium to large drones
Pitch	4.5 inches	Optimized for efficiency and thrust
Material	Nylon and Carbon Fiber Composite	Durable and lightweight
Weight	12g each	Minimizes added weight
Mounting Hole Diameter	6mm	Standard size for easy installation
Rotation	Available in both CW and CCW	Ensures balanced flight

6.4.10 Air2216 T-Motor (920KV)

Feature	Specification	Details
KV Rating	920KV	High-speed motor suitable for various applications
Max Continuous Current	20A	Handles high current loads
Max Power	350W	Provides high power output
Input Voltage	2-4S LiPo	Compatible with common LiPo batteries
Shaft Diameter	4mm	Standard size for many propellers
Stator Size	22 x 16 mm	Efficient power generation
Weight	56g	Balanced for reduced vibration
Mounting Hole Distance	16mm / 19mm	Fits various frame mounts
Material	High-quality materials	Durable construction
Design	Precision balanced	Low vibration and smooth operation

6.4.11 S550 Hexacopter Frame

Feature	Specification	Details
Material	Glass Fiber and Polyamide-Nylon	Durable and lightweight construction
Motor Mounting Holes	Standard 16/19mm spacing	Compatible with various motors
Wheelbase	550mm	Provides stable flight characteristics
Arm Length	220mm	Optimal for medium to large drones
Frame Weight	620g	Lightweight for better flight performance
Landing Gear	Integrated	Provides stability during takeoff and landing
Battery Mount	Central	Balanced for stable flight
Assembly	Pre-drilled holes and slots	Easy to assemble and disassemble
Flight Controller Mount	Compatible with standard controllers	Versatile for different setups
Maximum Payload	2-3kg	Suitable for carrying cameras and equipment
Color	Black with Red/White accents	High visibility for orientation

6.4.12 3s Li Po Battery

Feature	Specification	Details
Battery Type	Lithium Polymer (LiPo)	High energy density and lightweight
Nominal Voltage	11.1V	3S configuration (3 cells in series)
Capacity	8000mAh	Long flight duration
Discharge Rate	30C	Provides high current output
Max Continuous Discharge	240A	Supports high power applications
Max Burst Discharge	60C (480A)	Short-term high power capability
Charge Rate	1C-3C recommended, 5C max	Fast charging supported
Connector Type	XT60	Commonly used and reliable
Balance Connector Type	JST-XH	Standard for balancing cells
Dimensions	160 x 45 x 35 mm	Compact size for fitting in drone frames
Weight	580g	Moderate weight for capacity
Wire Gauge	10 AWG	Suitable for high current applications

6.4.13 Agriansh 4002 Earth 110 PSI Water Pump

Feature	Specification
Brand	Earth
Model Name/Number	4002
Material	Plastic
Pump Type	Sprayer Pump
Color	Black
Charger Current	1.7 A
Pressure	110 PSI
Flow	4.5 LPM
Voltage	12V
Usage/Application	Agriculture

6.4.14 Spraying Drone

Component	Specification
Frame	S550 Hexacopter Frame
Motor	Air2216 T-Motor (920KV)
ESC	Air20A ESC
Battery	Orange 11.1V 8000mAh 30C 3S Lithium Polymer
Flight Controller	Pixhawk V2.4.8 Flight Board
GPS Module	NEO-M8N GPS Module
Propeller	T1045 Propeller (CW & CCW)
Payload Capacity	Approximately 3272 grams
Range of Operation	Up to 2-3 kilometers
Endurance	Approximately 0.8 hours

6.5 Electronic components : (Used in our drone)

1. Flight Controller (Pix-Hawk 2.4.8),
2. Radio Control Transmitter &Receiver
3. Telemetry(433 MHz),
4. Agriansh Water Pump,
5. Mission Planner (ArduPilot,Software),
6. BLDC Motors,
7. ESCs (Air 20A T-Motor ESC),
8. Propellers(10”4.5),
9. LiPo battery (3 Cell)& Balance Charger,
10. Power Module,
11. Frame(550s Hex)& landing gears,
12. GPS module,
13. Voltage Controller,
14. Metallic Servo Motor
15. Pipes, Elbows

CHAPTER 7:- LITERATURE REVIEW

- Crop Spraying Benefits: The literature review underscores the advantages of using drones for crop spraying, including precision, efficiency, and reduced human labor.

- Enhanced Crop Management: Drone-based crop spraying offers the ability to manage crops more effectively by providing insights into soil conditions, plant health, and pest infestations through remote sensing.

- Reduced Health Risks: Manual spraying of pesticides can pose health risks to workers due to exposure to chemicals. Drones eliminate this risk by automating the process.

- Increased Crop Yield: The adoption of drone technology for crop spraying has the potential to increase crop yields by ensuring timely and accurate application of fertilizers and pesticides.

- Challenges in Current Indian Agriculture: The literature review highlights the challenges in India's agriculture sector, such as low-tech practices, unskilled labor, and insufficient electricity supply.

- Need for Innovation: Given the challenges, there is a clear need for innovative solutions in Indian agriculture. The adoption of drone-based crop spraying is one such innovation that can revolutionize farming practices.

- Improved Efficiency: Drones equipped with precision spraying capabilities can significantly improve the efficiency of pesticide and fertilizer application, reducing wastage and increasing productivity.

- Sustainable Agriculture: Precision agriculture enabled by drone technology aligns with the goal of sustainable farming practices by minimizing the environmental impact of chemical use.

- Precision and Accuracy: Drones can provide precise and accurate coverage, ensuring that the right amount of pesticides or fertilizers is applied to each area of the field.

- Opportunities for Integration: Integrating drones with other technologies, such as IoT and AI, opens up new opportunities for data-driven decision-making and enhanced farm management.

- Potential for Crop Monitoring: Drones can also be utilized for regular crop monitoring, enabling farmers to make timely adjustments for better crop health.

- Future Potential: The literature review suggests that the adoption of drone technology for crop spraying has immense future potential in India, and further research and development are required to harness its full benefits.

CHAPTER 8:- FUTURE WORK AND FUTURE SCOPE

In this our future work could be that we can use ML applications to detect disease of insects on the plants and time by time we can keep eye on the health of our crop.

By collecting crop photos in both the infrared and visible spectral ranges, drone can extract various features that are not visible to the naked eyes, offer insight to the health of plants.

The regular availibility of such crop information allow farmers to make necessary adjustments and improve crop management strategies.

Future developments and the incorporation of cutting-edge technologies are probably in store for the scope and utility of agricultural drones. Future developments and uses for drones in agriculture could include the following areas:

1.Integration of AI and Machine Learning:

More sophisticated machine learning (ML) and artificial intelligence (AI) algorithms may be used in agricultural drones of the future. Drones would therefore be able to evaluate large, complicated data sets, find trends in crop health, spot abnormalities, and give farmers practical advice for precision farming.

2.Independent Functioning:

Drones used in agriculture should be becoming more autonomous. Drones may be able to operate autonomously with the help of sophisticated navigation systems and obstacle avoidance technology, which would eliminate the need for human piloting and increase farmer productivity.

3.Technology Swarm:

Drone swarm operations may become more common. Drone fleets operating in unison may cover greater ground more quickly, speeding up data collecting and offering a more complete picture of the agricultural terrain.

4.Personalization and Adaptability:

Farm drones of the future may have modular designs that let farmers tailor them to their own requirements. This might contain easily swappable cameras, sensors, and other parts to accommodate various soil types, crops, and monitoring needs.

Drones with longer flying periods could result from advancements in energy efficiency and battery technologies. Drones with longer endurance would be able to monitor and collect more data and cover bigger areas in a single flight.

5.IoT and sensor network integration:

Drones used in agriculture could have a closer relationship with sensor networks and the Internet of Things (IoT). Real-time data sharing between drones and other on-farm equipment may be made possible by this integration, offering a more comprehensive picture of the farming environment.

6.Delivery of Inputs for Agriculture:

Deliveries of agricultural supplies like seeds, fertiliser, and insecticides may include drones more frequently. By applying these inputs precisely where needed, precision delivery systems could maximise resource efficiency and minimize.

7.Environmental Surveillance:

Drones used in agriculture could monitor the environment for reasons other than crop health. By offering insights into the entire ecosystem, they might be utilised to monitor water quality, evaluate the influence on the environment, and support sustainable farming practises.

8.Regulatory Structures:

As drones are used in agriculture, legislative frameworks to handle privacy, safety, and airspace management issues may change. Drone technology adoption in agriculture can be made more responsible and broad with the support of clear rules and norms.

9.Worldwide Networking:

Improved worldwide connectivity could be advantageous for drones, enabling farmers to monitor and manage their drones remotely from any location in the world. This has the potential to improve drone technology's scalability and accessibility for farmers with varying needs.

It's crucial to remember that technological breakthroughs, legislative changes, and heightened cooperation between tech companies, agricultural specialists, and regulatory agencies will probably all play a role in the future of agricultural drones.

These developments have the potential to completely change how farmers manage their crops and choose more sustainable and effective agricultural methods as the sector develops.

CHAPTER 9 :- BENEFITS OF DRONE IN FARMING

Drones used in agriculture provide farmers with a number of advantages that boost production, sustainability, and efficiency in farming operations. Farmers can benefit from agricultural drones in the following ways:

1. Crop Management and Surveillance:

Precision farming: High-resolution photographs of fields can be taken by drones fitted with a variety of sensors, including thermal and multispectral cameras. Farmers can use this information to optimise irrigation, diagnose nutrient deficits, monitor crop health, and detect illnesses.

2. Mapping the Field:

Precise Mapping: By producing intricate 3D maps of fields, drones can give farmers important insights about the terrain, condition of the soil, and patterns of drainage. Making better decisions about planting, irrigation, and general land management is aided by this data.

3.Identifying Pests and Diseases:

Early Detection: Drones fitted with specialised cameras and sensors are able to recognise early indicators of illnesses and pest infestations. Drones used in agriculture provide farmers with a number of advantages that boost production, sustainability, and efficiency in farming operations. Farmers can benefit from agricultural drones in the following ways:

4.Crop Management and Surveillance:

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6.Identifying Pests and Diseases:-

Early Detection: Drones fitted with specialised cameras and sensors are able to recognise early indicators of illnesses and pest infestations in crops.

7. Efficiency in terms of time and money:

Effective Scouting: Compared to conventional scouting techniques, drones can cover huge agricultural regions rapidly and effectively, saving farmers money on labour and time. This is especially helpful in places with difficult terrain or huge farms.

8. Remote Sensing:

Access to Hard-to-Reach Places: Drones are able to reach hard-to-get places, giving them a complete picture of the farm. Particularly useful for farmers with large or geographically varied land is this accessibility.

9.Crop Health Evaluation:

Drones are able to collect both visual and multispectral imagery, which gives farmers the ability to evaluate the general health and vigour of their crops. Making timely judgements on fertilisation, pest management, and other agronomic practises requires the use of this information.

10.Emergency Reaction:

Disaster Assessment: Drones can be used to quickly determine the degree of damage to infrastructure and crops following natural catastrophes like floods or wildfires. This data facilitates the preparation of insurance claims and rehabilitation initiatives. Agriculture drones use these skills to give farmers data-driven insights that help them make decisions that increase crop yields, lower input costs, and support sustainable farming methods.

- **Conclusion**

Farming needs to be automated and uplifted with the expandingtechnology to maintain the needs of the population.

Usage of drone in agriculture is one of the least researched field yet itholds a numerous opportunities for the researchers giving betteryields to the farmers.

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