A Project Report on

IOT ENABLED DRONE FOR SMART FARMING

Submitted for the partial fulfillment of the requirement of the degree of

BACHELOR OF TECHNOLOGY

In

ELECTRONICS AND COMMUNICATIONS ENGINEERING

Submitted by

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DECLARATION

I/We solemnly declare that the project report IOT ENABLED DRONE FOR SMART FARMING is based on our own work which was continuously carried out during the course of our study under the supervision of DR. ANKAN BHATTACHARYA.

I/We can confidently say that the report made and all the conclusions drawn are the actual outcome of our project work. We also declare that:

- The work contained in the report is original and has been done by us under the general supervision of our respected supervisor.
- The work has not been submitted by any other institution for any other purpose in this university.
- I/We have thoroughly followed the guidelines provided by the university while writing theproject report.
- I/We have properly explained every minute thing related to our project work and also giventhe proper sources in the references.

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ACKNOWLEDGEMENT

I/We are honored in documenting this project report on **IOT ENABLED DRONE FOR SMART FARMING** as a requirement for the award of B.Tech. Degree in Electronics and Communications Engineering. This document is a fruit of labour from the students and the professors. Though I/we, as the student, give all our joint effort to produce this workpiece, it would have been impossible without the extensive help from the teacher's side. It would be great pleasure to express our sincere thanks to **Dr. Ankan Bhattacharya, E.C.E Department, Hooghly Engineering & Technology College** who provided us a helping hand in this project. The suggestion given by him undoubtedly helped. The unflagging patience, enthusiastic guidance, and immense knowledge that he shared with us proved highly beneficial and were the sole reason in making our project both possible and successful.

I/We are obliged to the Head of the Department of E.C.E, Hooghly Engineering & Technology College**,** for his cordial support, valuable information, and guidance which helped us in completing this task through various stages. The blessing help and guidance given by sir time to time shall carry us a long way in the journey of life. We would also like to thank our Institute and other faculty members without members without whom this project would have been distant reality. The guidance and support from all members who contributed to this project was vital for the completion of the project.

Date: Name and Signature of Group Members

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CERTIFICATE

Certified that the Project Work entitled **IOT ENABLED DRONE FOR SMART FARMING** is a bona fide work carried out by **Aditya Ghosh, Sk Mofiz Hossain, Sudipta Mondal, Subham Ghosh, Amit Mondal** in fulfillment for the award of Bachelor of Technology in Electronics and Communication Engineering Department of the Maulana Abul Kalam Azad University of Technology, West Bengal. It is certified that all the correction/suggestions indicated for internal assessment have been incorporated in the report deposited in the departmental library. The Project Report has been approved as it satisfies the academic requirement in respect of Project Work prescribe for the said degree.

…………………………………………

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Examiner 1

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Examiner 2

ABSTRACT

With advancement of technology things are becoming simpler and easier for us. Automation plays an increasingly important role in the world economy and in daily experience. Last few decades have witnessed a rapid development in robotic technology. Different types of intelligent machines which facilitate various tasks in industry environment are becoming popular. The project presented here, focuses on designing an IOT ENABLED DRONE FOR SMART FARMING.

One of the main sources of income in India is agriculture. The production rate of crops in agriculture in India is very high according to recent surveys, which is a large number of primary sources of livelihood. But the agriculture is totally depending on some factors like pesticides, crop disease, fertilizers etc. but if we think about a large area of arable land then it will be very hard to maintain pesticides, crop disease, fertilizers etc. If the number of farmers in the arable land is less compared to the requirement, then it is to be very difficult to maintain the land properly. To avoid these serious problems, we are developing a project called the "IoT Enabled Drone for Smart Farming" This initiative aims to revolutionize agricultural techniques by integrating advanced IoT technologies with drone capabilities. More over the spraying pesticides like DDT (dichloro-diphenyl-trichloroethane), aldrin, dieldrin, endrin, hexachlorobenzene etc. affects our health poorly during spraying. To avoid these serious problems, we should use the UAV (Unmanned Arial Vehicles). To spray the different pesticides by the farmers takes few hours but in case of UAV it is more convenient as well as takes very less time approximately 5 to 10 minutes. Moreover, it cost effective. It costs approximately 40,000 INR. By using this UAV with the modern technology our society will enrich technically as well as it helps us to save the manpower. So, this device would be a very popular in the new ongoing developing Country.

CONTENTS

INTRODUCTION

Drone Technology can help revolutionize agriculture by optimizing agricultural operations. Agriculture in India constitutes more than 60% of occupation, and it serves to be the backbone of Indian economy. It is essential to improve the productivity and efficiency of agriculture by providing safe culture cultivation to the farmer. The various operations like spraying of pesticides and sprinkling fertilizers are harmful procedure for the farmer as it causes skin issues and respiratory problems. Drones can revolutionize agriculture by offering farmers major cost savings, enhanced efficiency and more profitability. Drones can help speedy surveys of vast stretches of land, map the cropping area, report on crop health and can improve spraying accuracy and irrigation system [1]. Hence use of drones could help farmers around the world to monitor their crops, fend off pests, and save time and money. The monitoring of the crops and the need for spraying pesticides and fertilizers at the correct moment and at the exact location of plants is an important parameter to increase the productivity of the crops that is an important component of precision farming. UAV (Unmanned Aerial Vehicle) or drones can be used in agricultural sectors which will reduce the time of operations and the hazardous effects that can be caused due to the spraying of pesticides and fertilizers [2, 3].

WORKING PRINCIPLE

Drones basically work when the motor creates thrust in the air; the air also creates a pushing force in the motor blade. This is the fundamental principle behind how a drone functions. If the RPM (Revolutions Per Minute) of the motor increases, the greater lifting will be generated, and vice versa. The motors should always rotate clockwise and anticlockwise according to their shape or design.

In Figure 1, connect the input power leads of ESCs (Electronic Speed Controllers) to the power distribution board and connect the output leads to the motor. Connect the yellow lead to the motor yellow lead and connect the red and black lead to the motor red and black lead vice versa to change the direction of the motor. Then connect the flight controller with ESCs (Electronic Speed Controllers) and connect a power module with the power distribution board, flight controller and battery. Then connect the GPS (Global Positioning System), telemetry, receiver, buzzer, and switch to the flight controller. Next, perform the programming and calibrations in mission planner software. The flight controller uses PPM (Pulse Position Modulation), and the transmitter uses PWM (Pulse Width Modulation). So, we need to use a PPM encoder module in the receiver where the PWM (Pulse Width Modulation) signal converts into a PPM (Pulse Position Modulation) signal.

Firstly, connect the battery to the PDB (Power Distribution Board) to energize the drone. Then turn on the transmitter to bind to the drone with it. After this, when we push the throttle up, the receiver gives the signal to the FC (flight controller). After this the flight controller gives a signal to the motor through the ESC (Electronic Speed Controller), and the motor creates thrust to lift the drone upwards straight. Similarly, when we need to move the drone forward, backward, left, right, or rotate according to its own axis, we need to click or push different buttons on the transmitter and the signal goes to the receiver, which sends the data to the flight controller. The flight controller sends different signals to the motor through the ESC (Electronic Speed Controller), and the motors rotate differently according to the transmitter order.

There are some auxiliary channels to control different sensors or motors. In my case, a servo motor is used to turn on the pump motor to spray. The GND pin of the pump motor is connected to the PDB (Power Distribution Board), and the +ve pin is connected through the servo arm to the PDB (Power Distribution Board). There is a spraying tank, which is connected to the pump motor through a pipe, and the spraying nozzle is connected to the output of the pump motor. When the transmitter gives a signal to the servo motor to arm down, then the circuit path is closed, and it starts spraying.

BLOCK DIAGRAM

The block diagram illustrates an IoT-based smart farming drone system, highlighting power distribution, flight control, six brushless motors with six ESCs, GPS navigation, a pesticide spraying mechanism, radio communication. It enables autonomous flight, precision spraying for improved farming efficiency.

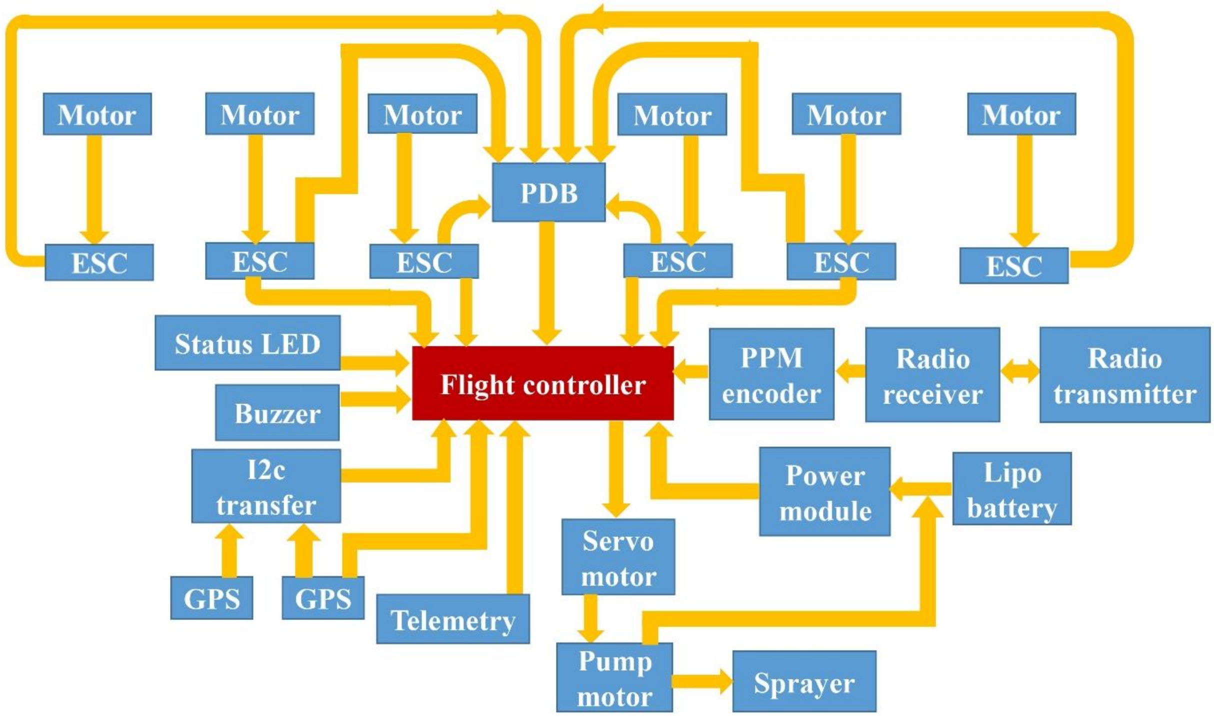

Figure 1: IoT Enabled Smart Farming Drone Block Diagram

COMPONENTS OF THE SYSTEM

Components Specification

To build the IOT based cost effective drone we need 4 BLDC motors, 4 ESCs, frame, battery, battery charger, power module, PDB, flight controller, PPM encoder, transmitter and receiver, GPS, propeller, limit switch, buzzer, etc.

TABLE: I Component Specifications with cost.

SL NO.	Component	Specification	Cost in INR
1.	Brushless DC motors with bullet connectors	High-efficiency motors (e.g., 920KV) with 3.5mm or 4mm bullet connectors for stable performance in drones.	3,000.00
2.	ESC (Electronic Speed Controller)	30A or 40A ESCs with LiPo compatibility for precise motor speed control.	3,000.00
3.	Hexa S550 X frame	Durable, lightweight quadcopter frame with 450mm wheelbase for stable flight.	4600.00
4.	Lipo Battery	3S-4S (11.1V-14.8V) high-capacity lithium polymer battery, typically 2200-5000 mAh for extended flight times.	2,600.00
5.	Lipo balance charger	Intelligent charger with balance capabilities for safe charging of multi- cell LiPo batteries.	1,950.00
6.	Power module	Voltage and current-sensing module (e.g., 5V/12V output) to power the flight controller and other components.	650.00
7.	PDB board with XT60/T connector	Central power hub with XT60 or T connectors to distribute power to all drone components.	450.00

8.	Flight controller	Autonomous controller (e.g., Radiolink cross flight) for stabilization, navigation, and data processing.	5000.00
9.	I2C transfer board	Used to connect corresponding I2C modules such as one ultrasonic sensors to achieve altitude holding, an LED module or extra GPS.	400.00
10.	PPM encoder/decoder	Signal converter for combining multiple PWM signals into a single PPM output for the flight controller.	600.00
11.	Transmitter and receiver	Remote control system (e.g., 2.4 GHz, 6-8 channels) for user-controlled drone operation	5,250.00
12.	GPS	GPS receiver for precise positioning and autonomous navigation.	4,400.00
13.	Telemetry	Automatically collect, transmit, and measure data from remote sources using sensors and other devices. This helps the drone to fly autonomously.	5500.00
14.	Propellers	10-inch or 12-inch durable plastic or carbon-fiber props for efficient thrust and stability.	200.00
15.	Flight controller status indicator	It indicates in which direction the drone is in the mid-air we can understand which part of the drone is front & which one is back.	500.00
16.	Buzzer	Audible alert system for low battery or signal loss warnings.	50.00
17.	Shock absorber	Vibration-damping components to reduce impact on the frame during landings.	300.00

18.	Vero board	Soldering-friendly board for custom circuit assembly and component integration.	30.00
19.	Jumper wires	Flexible connector wires for circuit testing and component linkage.	160.00
20.	Pump motor	Compact DC pump motor for liquid distribution in spraying applications.	200.00
21.	Pipe	Flexible tubing for directing liquid from the pump to nozzles.	20.00
22.	5way connector	Multi-port connector to split liquid or electrical pathways.	528.00
23.	Nozzles	Spray nozzles for controlled liquid dispersion in agriculture.	300.00
24.	Water tank	Lightweight, drone mounted water reservoir for carrying spraying solutions.	20.00
25.	Servo motor	Small DC motor with precision control for actuator applications (e.g., nozzle positioning).	100.00

COST CALCULATION

The existing systems available for smart farming [6, 7] are costly but our proposed one is cost effective.

The cost calculation is as follows:

TABLE II: Component details with count and cost

SL NO.	NAME OF THE COMPONENT	PRICE IN INR	NUMBER OF COMPONENTS
1.	Brushless DC motors with bullet connectors	3,000.00	6
2.	ESC	3,000.00	6
3.	Hexa S550 frame	4,600.00	1
4.	Lipo Battery	2,600.00	1
5.	Lipo balance charger	1,950.00	1
6.	Power module	650.00	1
7.	PDB board with XT60/T connector	450.00	1
8.	Flight controller	5,000.00	1
9.	PPM encoder/decoder	600.00	1
10.	Transmitter and receiver	5,250.00	1
11.	Telemetry	5500.00	1
12.	GPS	4,400.00	2
13.	Propellers	200.00	4
14.	Flight controller status indicator	500.00	1
15.	Buzzer	50.00	1
16.	Shock absorber	300.00	1
17.	Vero board	30.00	1
18.	Jumper wires	160.00	40
19.	Pump motor	200.00	1
20.	Pipe (1 m)	20.00	1
21.	5way connector	528.00	1
22.	Nozzles	300.00	4
23.	Water tank (500 ml)	20.00	1
24.	Servo motor	100.00	1
25.	I2C transfer board	400.00	1
Total		INR 39,808/-	

FUNCTIONAL DESCRIPTION

The smart agricultural drone is designed to automate critical farming tasks such as crop health monitoring, precision spraying, and environmental data collection, allowing farmers to increase productivity and efficiency. Equipped with various sensors, GPS, and a flight controller, the drone autonomously flies over fields, collecting real-time data on crop conditions and environmental parameters.

Hardware Details

TABLE III: Hardware specifications

SL NO.	Name of the Components	Specification
1.	Brushless DC motor with bullet connectors	Motor specification: Tiles: 12 Operating voltage: 12V KV rating: 920 KV Full load current(max): 50amp Bullet connector specification: Material: - Aluminum
2.	ESC	Operating current: 5amp to 60amp Operating voltage: 10V to 14V
3.	Hexa S550 frame	Material: Glass fiber Length according to diagonal: 55cmTotal area: 1012.5cm
4.	Lipo battery	Max voltage: 12.6VMin. voltage: 10.5V Max. outburst discharge rate: 400amps No. of cells: 3

5.	Lipo balance charger	Model: - IMAX B6 DC Input Voltage Range (V): - 11 ~ 18 Output Power (Watt): - 80W (max) Charge Current Range (A): - 0.1 ~ 6 Maximum Discharge Power (W): - 5 Discharge Current Range (A): - 0.1 ~ 1.0Drain Current for Balancing Li-Po's (mA/Cell): - 300 Li-ion/Po cell count: - 1 ~ 6 . NiCd/NiMH cell count: - 1 ~ 15 Cells . Pb battery voltage: - 2 ~ 20
6.	Power module	Operating Voltage (VDC): - 6 to 28Max input voltage (VDC): - 28 Max current sensing(A): - 90 Connector Type: - XT60
7.	PDB (power distribution board) board and XT60/T connector	PDB Channel: 6 ways Max. current output: 250 amps
8.	Flight controller	**Features: -** 1. Advanced gyroscopic sensors for precise flight control 2. Responsive flight algorithms for accurate maneuvering. 3. Suitable for beginners and seasoned drone enthusiasts 4. Exceptional control and stability for various drone applications 5. Sleek and compact design for easy installation 6. Compatibility with Radiolink transmitters and receivers 7. User-friendly interface for simple setup and configuration 8. Versatile functionality for aerial photography and FPV racing

		Specification: - 1. Processor : HC32F4A0PITB 2. Input Voltage (V) : 2 to 12S 3. Input Current (A) : 90 4. Output Voltage (V) : 5.1 5. Output Current (A) : 2.5 6. PWM Output : 10 7. USB : USB Type-C 8. USB Input voltage(V) : 5V+/-0.3V 9. Operating Temperature (°C) : -40 to 80
9.	PPM encoder/decoder	Input Channel: - 8 PWM channel Output channel: - 1 PPM channel
10.	I2C transfer board	Port Quantity: 4 Port: 1 Input Port, 2 I2C Ports and 1 GPS Serial Port. Compatible Module: Compatible with Ultrasonic Sensors, LED module or extra GPS
11.	Transmitter and Receiver	fly sky fs-i6 Transmitter Specifications: Model Type: Glider/Helicopter/ Airplane And: 142 2.4ghz System: AFHDS 2A and AFHDSCode Type: GFSK DSC Port: PS2 Output: PPM Charger Port: No ANT length: 26mm*2(dual antenna) Online update: Yes Certificate: CE0678, FCC Model Memories: 20 Channel Order: Aileron-CH1, Elevator-CH2 Throttle-CH3, Rudder-CH4, CH 5 & 6 open assignment to other functions.

		FS-iA6B Receiver Specifications Channel: 6. Frequency Range: 2.4055–2.475 GHz. Band Width Number: 140 Transmitting Power: ≤ 20 dBm. RF Receiver Sensitivity: 105 dBm. 2.4G Mode: The second generation of an enhanced version of the automatic FM digital system. Encoding: GFSK. Antenna Length: 2 x 26 mm (dual antenna). Input Power: 4.0 – 8.4 VDC (2A). Data Acquisition Interface: Yes. Model Type: Airplane / Glider / Helicopter. Compatible Transmitter: Compatible with FS-i4, FS-i6, FS-i10, FS-GT2E, FS-GT2G.
12.	GPS	Model: - Ublox NEO-M8N Acceleration range: - <4 Input Supply Voltage: - 0.5 - 3.6 VDC Operating Temperature Range: - -45°C to105°C Receiver Type: - 72-channel Ublox M8Engine Sensitivity: - Tracking & Navigation: -161dBm Tracking Sensitivity: - -161 dBm
13.	Propellers	Propeller specification: Material: - ABS Colour: - Black Length (Inch): - 10 Pitch (inch): - 4.5
14.	Flight controller status indicator	It is an IC based mini-PCB board, where two colours indicate different situations.

15.	Telemetry	Antenna Type: RP-SMA connector Frequency: 915 MHz Interface: Standard TTL UART Power: 500MW Sensitivity: Antennas Included-117dBm sensitivity Features: • 2km Range • Compatible with Multiple Platforms • 915MHz ISM band • Bidirectional Communication • Plug-and-Play • Low Latency and High Efficiency • Small and Lightweight • Integrated LEDs
16.	Buzzer	Volume (dB): - 50 Interface: - 1.25-2P plug
17.	Shock absorber	Colour: - Black Material Glass Fiber
18.	Vero board	Base Material: - Phenolic paper board Copper Thickness (mm): - 1-4 Oz
19.	Jumper wires	Cable Type: - Female to Female Length (mm): - 400
20.	Pump motor	Operating Voltage (VDC): - 12 Operating Current: - 500mA to 1.5-amp Flow Rate (L/H): - 120 Continuous Working Life (hours): - 500 Driving Mode: - DC, Magnetic Driving Outlet Outside Diameter (mm): - 7.35 Outlet Inside Diameter (mm): - 4.5

21.	Pipe with 5-way connector and nozzle and water tank	Pipe specification: Material: - PVC Inner Diameter: 6mmOuter Diameter: 8mm 5-way connector specification: Material: - plastic Inner Diameter: -7mm Outer Diameter: - 8mm Nozzle specification: Material: Brash Outer Diameter: - 8mmWater tank Colour: - White Material: - Plastic
22.	Servo motor	Model: - SG90 Weight(gm): - 9 Operating Voltage (VDC): - 3.0 ~ 7.2 Operating Speed @4.8V: - 0.10sec/60° Stall Torque @ 4.8V (Kg-Cm): - 1.2 Stall Torque @6.6V (Kg-Cm): - 1.6 Operating Temperature (°C): - -30 to 60Dead Band Width (µs): - 7 Gear Type: - Glass Fiber Rotational Degree: - 180º Servo Plug: - JR Cable Length (cm): - 25

Software Details

TABLE IV: Software specifications

SL No.	Software Used
1.	Mission Planner

Hardware Description

- **Brushless Dc Motor and Bullet Connector: -**

  The A2212 920KV motor is a BLDC brushless out runner motor specifically made for quad copters and multi-rotors. It provides high performance and brilliant efficiency. This, 920KV motor has the capacity to lift around 900 grams. At full load a single motor can consume up to 50amp. These brushless BLDC motors are perfect for medium size quad copters with 8-inch to 10-inch propellers. KV= RPM per volt. So, a 920kv motor supplied with 12V will spin at 11,040 rpm [8, 9].

Figure 2: A2212 920KV Brushless Motor

- **ESC: -**

  ESC stands for Electronic Speed Controllers (ESCs) are devices that allow drone flight controllers to control and adjust the speed of the aircraft's electric motors. A signal from the flight controller causes the ESC to raise or lower the voltage to the motor as required. In my case I used 30amp ESC which can supply maximum 30amp current to the motor [10].

Figure 3: Simonk 30A ESC (Electronic Speed Controller)

- **Hexa S550 Frame: -**

This is Hexacopter Frame which employs 6 arms to get into the air. For 6 arms, of course, there are more motors with a hexacopter meaning more power, meaning bigger batteries. This increase in batteries leads to an increase in flight time, which is also nice. Due to these extra motors, a hexacopter is also more stable than your quadcopter equivalent. The S500 has strong, light, and have a sensible configuration including a PCB (Printed Circuit Board) with which you can directly solder your ESC's to the Quadcopter. So, making the Quadcopter build fast and easy. So, it avoids the use of extra PDB (Power Distribution Board) and makes the mounting clean and neat. The S550 Hexacopter Frame is a highly flexible frame during the mounting of various components like flight controller, battery, etc.

Figure 4: S550 Hexacopter Frame

- **Lipo Battery: -**

LiPo stands for Lithium-ion Polymer battery. It is a rechargeable battery that, uses solid polymer for the electrolyte and lithium for one of the electrodes. It is a 3 cell means 12V battery and has a high discharge rate up to 400 amp [11].

Figure 5: Lithium polymer (LiPo) battery

- **Lipo Balance Charger: -**

The balance charger monitors the voltages of individual cells in the pack via a connector present on the pack. It then adjusts the rate of charge accordingly. This process is referred to as balance charging. It is prudent to mention that LiPo batteries can explode or even catch fire if you do not handle them correctly [12].

Figure 6: LiPo Balance Charger

- **Power Module: -**

A battery Eliminator circuit is a type of voltage regulator.it is used to prevent high voltage towards the ESC's and pass the required voltage which is essential. As modern RC airplanes use high voltage batteries, it allows you to run your receiver, servos, and other accessories from your main battery without using a separate lower voltage one [11]. The Radiolink CrossFlight Power Module is a simple way of providing your Radiolink CrossFlight with clean power from a LiPo battery as well as current consumption and battery voltage measurements, all through a6-pos cable. The on-board switching regulator outputs 5.3V and a maximum of 2.25A from a 2S-6S LiPo battery. Also, the circuit detects a sensing current around 90 A [13].

Figure 7: Radiolink CrossFlight Power Module

- **PDB Board and XT60/T Connector: -**

PDB (Power Distribution Board) is a special board which allows transferring the power from the battery to ESCs / Motors and generate power supply for the flight controller and other peripherals with different voltage levels [14].

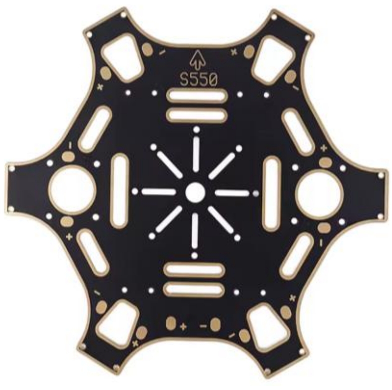

Figure 8: Power distribution board (PDB)

- **Flight Controller: -**

The flight controller is the brain of a drone. A small box filled with intelligent electronics and software, which monitors and controls everything the drone does [15]. And just like the brains of different organisms, flight controllers also vary in sizes and complexity. In my case I use Radiolink CrossFlight V1.0 flight controller [16].

Figure 9: Radiolink CrossFlight V1.0 Flight Controller

- **I2C Transfer Board: -**

Radio link I2C Transfer Board extend the I2C port quantity of the Flight Controller. The two I2C ports can be used to connect corresponding I2C modules such as one ultrasonic sensor to achieve altitude holding, an LED module or GPS.

The two ports in the middle of Radio link I2C Transfer Board are I2C ports which extend that of the flight controller as two. One of the two ports on both sides is for input while the other is for GPS module.

Specifications:

Port Quantity: 4

Port: 1 Input Port, 2 I2C Ports and 1 GPS Serial Port.

Compatible Module: Compatible with Radio Link Ultrasonic Sensor, LED module or extra GPS.

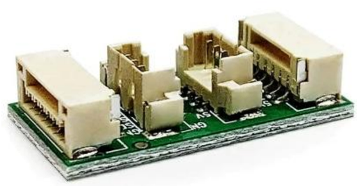

Figure 10: I2C Transfer Board

- **PPM Encoder/Decoder: -**

  Pulse position modulation (PPM) encoding is the system where encoding is carried out by positioning the pulses. The PPM encoder allows to encode up to 8 PWM (pulse width modulated) signals into one PPM (pulse position modulation) signal. Some flight controllers such as the Pixhawk autopilot only support PPM (pulse position modulation) compatible receivers. If you have a PWM (pulse width modulated) receiver, you will need a PPM encoder such as this one for it to work with a PPM-only FC [17].

Figure 11: PPM encoder/decoder

- **Transmitter and Receiver: -**

  A Drone Radio Transmitter is an electronic device that uses radio signals to transmit commands wirelessly via a set radio frequency over to the Radio Receiver and the receiver on a drone is an electronic device that uses built-in antennas to receive radio signals from the transmitter. But the receiver doesn't just receive signals from the transmitter. It also interprets the signals and converts them into alternating current pulses [18].

Figure 12: Transmitter and Receiver

- **GPS: -**

  The most common use of GPS in drones is navigation. A central component of most navigation systems on a drone, GPS is used to determine the position of the vehicle. The relative positioning and speed of the vehicle are also usually determined by the drones GPS [19].

Figure 13: Neo M8n GPS (Global Positioning System)

- **Propellers: -**

  These Orange Propellers are light in weight and high strength propeller has a 15° angle design at the end of the propeller to avoid whirlpool while the multi-copter is flying. They are useful in drones as well as in multi-copters [20].

Figure 14: 1045 Propeller

- **Flight Controller (FC) Status Indicator LED: -**

  It is an IC based mini-PCB board which is connected to the flight controller through I2C, it basically indicates status of the flight controller using three different colours.

  LED Meaning:

  Red light blinking – The pre-arm checks will run automatically if any problem are found the red light will blink twice.

  Red & Blue blinking – It indicates the status of ESC calibration.

  Green light blinking – it indicates the drone is ready to take off.

Figure 15: Flight Controller Status Indicator LED

- **Telemetry: -**

The 3DR 915MHz 500mW Radio Telemetry Module is a high-performance communication solution for flight controllers. Operating on 915MHz, it delivers reliable, long-range data transmission with up to 500mW power output. Its compact design and lightweight construction ensure easy integration with drones and UAV systems. Featuring transparent data transfer, it supports seamless communication between ground control stations and on-board systems. The module comes with built-in error correction to ensure data integrity, even in challenging environments. Ideal for professional drone pilots and developers, it enhances remote monitoring and mission control efficiency [21].

Figure 16: Telemetry

- **Buzzer: -**

Buzzer is used to indicate when the different calibrations are done and if there any fault or battery low or any type of danger in the drone system.

Figure 17: Passive Buzzer

- **Shock Absorber: -**

If the drone crashed or a hard landing the sensors inside of the flight controller can be damaged. To avoid this problem shock absorber is used [22].

Figure 18: Anti Vibration Shock Absorber

- **Jumper Wires: -**

  It is very flexible and easily detachable to no. of wires according to your requirement. It is compatible with 2.54 mm spacing pin headers. In my case I used female to female jumper wires.

Figure 19: Jumper wires

- **Veroboard: -**

  It is required to control the spraying system in the drone.

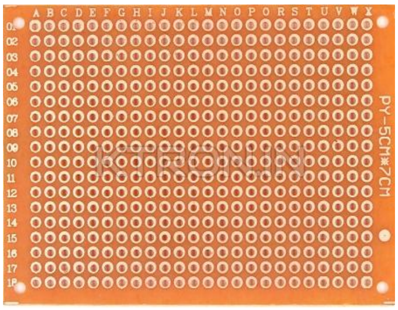

Figure 20: Veroboard

- **DC Pump Motor: -**

  The Submersible Pump Motor which can be operated from a 12V power supply. It can take up to 270 litters per hour with a low current consumption of 1.5 Amp. Maximum pressure up to 100 psi [23].

Figure 21: Submersible Pump Motor

- **Pipe With 5 Way Connector and Nozzle and Water Tank: -**

  At first the pipe is connected from the output of the water tank to the pump motor. Then the output of the pump motor is connected to the input of the 5-way connector. After this the 4 outputs of the connector will connect to the mist spraying nozzle which were situated in the 4 legs of the drones through the pipe.

Figure 22: Mini Hose Pipe Connectors

Figure 23: Pipe

Figure 24: Mist Spraying Nozzle

- **Servo Motor: -**

  The Tower-Pro SG90 9g Mini Servo is a 180° rotation servo. It is a Digital Servo Motor that receives and processes PWM signal faster and better. It equips sophisticated internal circuitry that provides good torque, holding power, and faster updates in response to external forces. In my case I use it as a wireless switch by which I can turn on or off the pump motor wirelessly [24].

Figure 25: Servo Motor

Modular Connections

According to the below connection diagram, each motor is connected to the ESC (electronic speed controller). Each ESC signal lead is connected in the main out of the Radiolink CrossFlight V1.0 flight controller and the power leads are connected to the PDB (power distribution board). The battery is connected to the input power lead of the power module and the signal lead of the power module is connected to the flight controller, whereas the output power lead of the power module is connected to the PDB. The receiver is connected to the PPM encoder and the output of the encoder is connected to the "RC in" of Radiolink CrossFlight flight controller. The limit switch, buzzer, and GPS (global positioning system) are also connected to Pixhawk flight controller. The servo is connected to the main out of the Radiolink CrossFlight flight controller. The Pump motor circuit is closed through the servo motor.

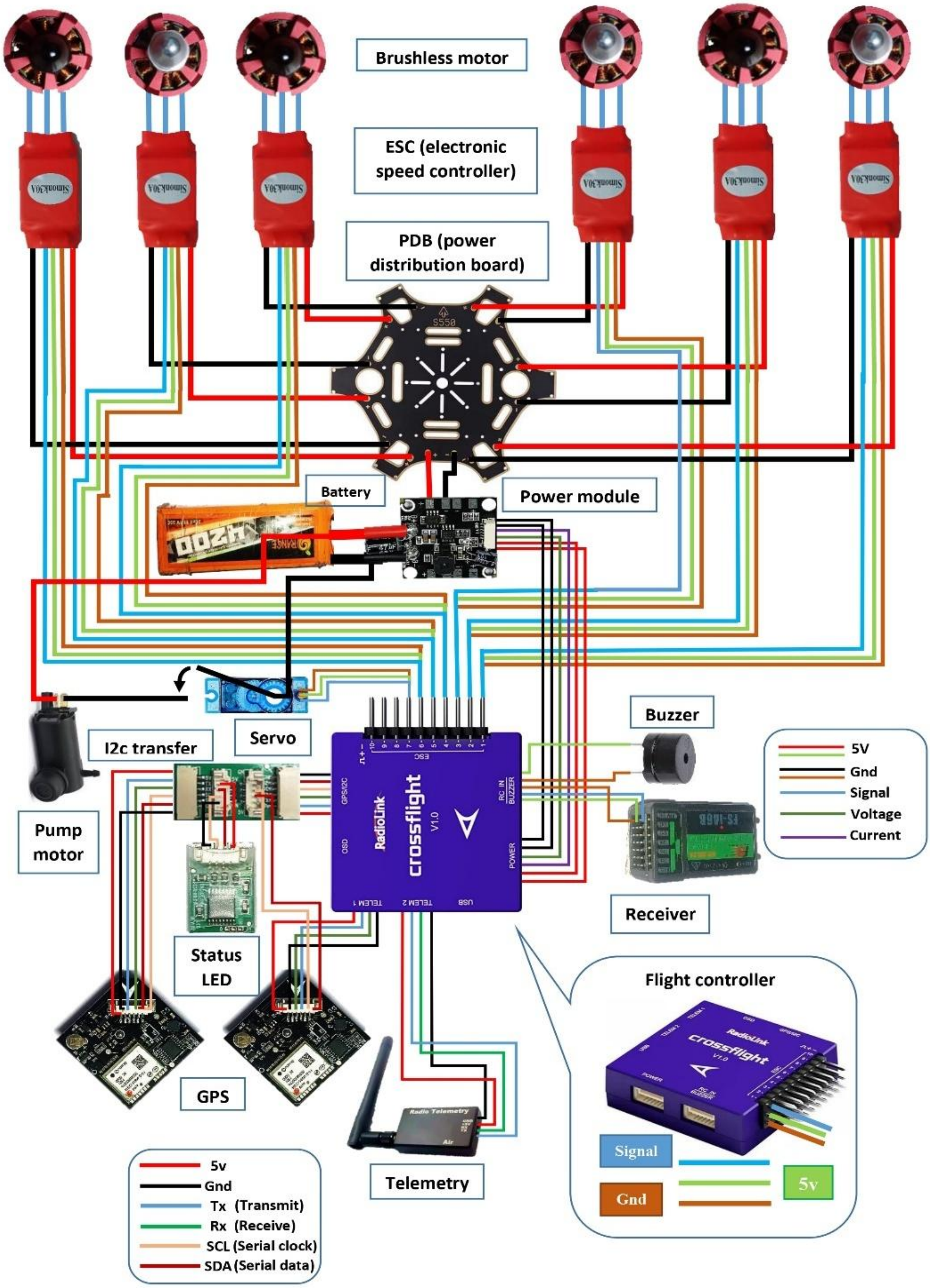

Figure 26: Modular Connections

RESULTS

We are manufacturing drone for agriculture purpose. Drones can help farmers to optimize the use of inputs (seed, fertilizers, water), to react more quickly to threats (weeds, pests, fungi), to save time crop scouting (validate treatment/actions taken), to improve variable-rate prescriptions in real time and estimate yield from a field. Drone manufacturers are certain that aerial spraying would not just be more focused and effective, it would substantially reduce input costs, increase the quality and quantity of yield as well as make agriculture more sustainable. In 150 crore population of India only 100 drones are used. Which is very less because of the high price of the drone. But our team can build the drone in half price than drones available in market. So, which might get huge demand in the market. Before marketing this product, we have already sketched the SWOT analysis of our venture. This analysis is given below.

- **S: Strength**

  Some brilliant features like fully autonomous, Loiter, constant altitude, wide range of 12km, maximum height of 10km, collision avoidance technology, water proof are the strength of our venture.

- **W: Weaknesses**

  Though this product is exclusive and very useful for farmers but operating drones require trained staff and continuous monitoring from the ground (continuous monitoring is not need in autonomous mode). Unlike commercial planes and helicopters, drones cannot carry heavier payloads or deliver goods long distances. And most important the rules regulations and legality.

- **O: Opportunities**

  In Indian market this agricultural drone is a new technique in agriculture. According to recent surveys there are only 100 agricultural drones are in action at this time in India. PM Narendra Modi tweet that this number of drones will grow up to 1 lakh drones in next 2 years. This increment in technology in agriculture will be our opportunity.

- **T: Threats**

  Though we have limited capital, so we might not go for patents right initially which might a threat of our product.

Figure 27: IoT Enabled Drone for Smart Farming

Our main objective of marketing would be earning profits through providing our customers the best services handling consumers complaints providing after sales services, maintain good relation with the customer will be out main marketing strategies. For publicity and advertisement of our product will be Opt. for the farmers. Advertising through a Newspaper social media like Facebook, Twitter and Instagram we can also advertise in various well-known magazines. We can go to organize and provided with presentation for our model to attract them and help Understand better. We will communicate individually to these types of customers and tell them about its unique features. Advertisement will help us to reach customer easily and help and sale promotion which encourages them to buy our product. This will be our prime marketing plan.

Results and Observations in Drone for Smart Agriculture

1. **Improved Crop Monitoring:**
   - **Observation:** Drones equipped with multispectral and thermal cameras provide detailed aerial imagery.
   - **Result:** Farmers can monitor crop health, detect diseases early, and assess soil conditions more accurately, leading to timely interventions and better crop management.
2. **Precision Agriculture:**
   - **Observation:** Drones enable precise application of fertilizers, pesticides, and herbicides.
   - **Result:** This targeted approach reduces chemical usage, minimizes environmental impact, and optimizes resource utilization, enhancing overall farm productivity.
3. **Enhanced Data Collection:**
   - **Observation:** Drones collect vast amounts of data on crop growth, soil moisture, and field conditions.
   - **Result:** Advanced analytics and machine learning algorithms process this data to provide actionable insights, helping farmers make informed decisions and improve yield predictions.
4. **Cost and Time Efficiency:**
   - **Observation:** Drones cover large areas quickly and efficiently compared to traditionalmethods.
   - **Result:** This reduces labour costs and saves time, allowing farmers to focus on other critical tasks and improving overall farm management efficiency.
5. **Real-Time Monitoring:**
   - **Observation:** Drones provide real-time data and live video feeds.
   - **Result:** Farmers can monitor their fields continuously, respond to issues promptly, and make adjustments in real-time, leading to better crop outcomes.
6. **Sustainability:**
   - **Observation:** The use of drones promotes sustainable farming practices.
   - **Result:** By optimizing resource use and reducing chemical runoff, drones help in maintaining soil health and protecting the environment.

APPLICATIONS

Drones are revolutionizing smart agriculture by providing farmers with valuable data insights, reducing labour costs, and enabling precision farming practices [25]. Here's how drones are being used effectively in this field:

1. Crop Monitoring and Field Analysis

- **Real-time Crop Health Monitoring**: Drones with multispectral or thermal sensors canassess plant health by detecting infrared light, allowing farmers to spot diseases, pests,or water stress early.
- **Soil and Field Analysis**: By conducting topographic mapping, drones help in planning irrigation patterns and identifying areas where the soil is poor in nutrients, saving timeand resources.

2. Precision Spraying and Fertilizer Application

- **Targeted Spraying**: Drones can carry payloads of fertilizers, pesticides, and herbicides, delivering them precisely where needed. This minimizes chemical use, lowers costs, and reduces environmental impact.
- **Variable Rate Application**: Equipped with AI, drones can adjust the application rate based on the crop's requirements, providing a customized approach that optimizes cropyield and resource use.

3. Irrigation Management

- **Water Stress Detection**: Drones equipped with thermal sensors can monitor crop hydration levels by detecting areas that need more or less water.
- **Efficient Water Use**: Data collected allows farmers to optimize water usage, ensuring plants get the right amount of hydration while conserving water resources.

4. Livestock Monitoring

- **Livestock Tracking**: Drones provide real-time visuals, allowing farmers to track the location and health of their livestock over large areas.
- **Behavior Analysis**: Using AI, drones can detect behavioral patterns, such as signs of disease or distress, in livestock, allowing for timely intervention.

5. Planting and Seeding

- **Drone-Driven Planting**: Some drones can drop seeds and fertilizers directly into the soil, promoting growth in areas that are hard to reach manually. This is particularly helpful for reforestation or planting in difficult terrain.

- **Data-Backed Planting Decisions**: Based on soil and environmental data, drones can inform planting strategies that enhance crop yield and minimize risk.

6. Yield Prediction and Harvest Planning

- **Estimating Crop Yield**: Drones use image analysis to gauge crop density and health, giving accurate yield predictions that help farmers plan storage and logistics.
- **Optimized Harvesting**: With real-time monitoring, drones inform farmers of the best harvest time, reducing crop loss and maximizing quality.

7. Technologies Involved in Agricultural Drones

- **Sensors**: Multispectral, hyperspectral, thermal, and RGB cameras provide comprehensive data on crop health, moisture levels, and soil composition.
- **GPS and GIS Integration**: GPS technology enables drones to navigate and execute tasks precisely, while Geographic Information Systems (GIS) analyze spatial data to make informed decisions.
- **AI and Machine Learning**: AI helps analyze the data collected by drones, providing actionable insights such as identifying diseases, estimating yield, and mapping nutrientrequirements.

8. Benefits of Using Drones in Smart Agriculture

- **Cost Efficiency**: By reducing labour, water, and chemical usage, drones lower operational costs.
- **Improved Yield**: Through targeted and timely interventions, drones can help increase crop yields and ensure higher quality produce.
- **Environmental Sustainability**: Drones help cut down on excessive chemical use, conserve water, and reduce soil degradation.

9. Challenges and Considerations

- **Initial Costs and Maintenance**: Drones and their required technologies can be expensive to acquire and maintain.
- **Data Security and Privacy**: With drones capturing data over vast fields, ensuring that this data remains secure is essential.
- **Weather Dependency**: Drones may not perform optimally in adverse weather conditions, which could delay time-sensitive tasks.

FUTURE SCOPE OF THE PROJECT

The future scope of IoT Based Cost Effective Drone for Smart Farming is promising, as advancing technology is set to further enhance agricultural practices through precision, efficiency, and sustainability. Here are some anticipated developments:

1. Enhanced Data Integration with IoT and AI

- **Real-time Data Fusion:** Drones will increasingly integrate with the Internet of Things (IoT) and AI to collect, analyze, and communicate data instantly. This interconnected system will enable comprehensive farm monitoring, from soil health to weather patterns, allowing farmers to make data-driven decisions in real time.
- **Predictive Analytics:** AI-powered analytics will predict crop health trends, potential pest infestations, and yield outcomes, enabling proactive farm management.

2. Autonomous Drones for Continuous Monitoring

- **Fully Autonomous Operations:** The future may see drones that require minimal human intervention, autonomously monitoring fields, analyzing data, and even adjusting flight paths based on changing environmental conditions.
- **Automated Data Processing:** With AI and machine learning advancements, drones will autonomously analyze collected data, immediately alerting farmers to any detected issues and providing suggested actions.

3. Drone Swarms for Large-Scale Precision Agriculture

- **Collaborative Swarms:** Drone swarms—multiple drones working in coordination—will enable faster, more comprehensive field coverage, particularly for large-scale farms. Each drone could specialize in a specific task, like soil sampling, crop health analysis, or irrigation monitoring.
- **Efficient Resource Distribution:** Swarms could perform synchronized tasks such as pesticide application, seeding, or fertilizing, enhancing accuracy and reducing the time needed for larger operations.

4. Advances in Precision Spraying and Micro-Dosing

- **Precise Micro-Dosing**: Drones will become even more adept at identifying the precise areas needing fertilization, pesticides, or water, applying these resources at micro levels for maximum efficiency.
- **Reduced Chemical Usage**: By precisely targeting affected plants, drones will significantly reduce chemical usage, promoting environmental sustainability and minimizing residue on crops.

5. 3D Imaging and Plant Health Modelling

- **High-Definition 3D Crop Models**: Future drones will be equipped with advanced imaging technologies that create detailed 3D models of crops, allowing farmers to assess plant growth, detect irregularities, and monitor individual plant health.
- **Early Disease and Pest Detection:** Drones will identify diseases or pests at their earliest stages, before visible symptoms appear, using high-resolution imaging combined with AI-based pattern recognition.

6. Sustainable Farming through Precision Resource Management

- **Water Conservation**: Drones equipped with thermal and moisture sensors will enable hyper-efficient irrigation practices, reducing water usage and preserving resources in drought-prone regions.
- **Carbon Footprint Reduction**: As drones improve in applying resources more accurately, farms will use less fuel and fewer chemicals, reducing their overall environmental impact and carbon footprint.

7. Integration with Robotics and Automated Farm Equipment

- **Drone and Robot Collaboration**: Future drones will work alongside ground robots, coordinating to handle tasks such as automated harvesting, planting, and soil sampling.
- **Comprehensive Crop Management Systems**: The collaboration of drones, ground robots, and IoT sensors will create an interconnected, automated farm where tasks are efficiently managed without human intervention.

8. Improved Livestock Management and Animal Welfare

- **Drone-Assisted Livestock Health Monitoring**: Drones will track livestock health and movement more accurately, potentially identifying animals showing signs of illness or distress through behavioral analysis.
- **Virtual Fencing and Herding**: Drones may one day assist with herding livestock, creating virtual boundaries and reducing the need for traditional fencing.

9. Blockchain and Traceability in Agriculture

- **Supply Chain Transparency**: Drones can capture data on crop origin, health, and harvesting processes, integrating this data with blockchain systems to provide end-to-end transparency in the food supply chain.
- **Enhanced Crop Certification**: Using verified drone-collected data, farmers can offer higher-quality certification for organic or sustainably grown crops, meeting consumer demand for transparency.

10. Government and Policy Support for Agricultural Drones

- **Subsidies and Incentives**: As drones become essential in sustainable farming, governments may incentivize farmers to adopt drone technology, including tax breaks, subsidies, or grants.
- **Regulatory Developments**: Anticipated policy shifts could facilitate more flexible and widespread drone use, particularly as the technology is recognized for its environmental and productivity benefits.

CONCLUSION

Drones have formerly extensively altered agricultural assiduity and will continue to grow in the coming times. While drone use is getting more useful to small growers, there is still a way to go before they come part of every planter's outfit canon, particularly in developing nations. Regulations around drone use need to be made and revised in numerous countries, and further exploration needs to be done on their effectiveness at certain tasks, such as fungicide operation and spraying. There are numerous ways drones can be useful to growers, but it is important to understand their limitations and functions before investing in a precious outfit. Drone Deploy, an agrarian drone supplier and programming company, suggests starting small and incorporating drone data into your association sluggishly for the stylish results.

Our cost-effective smart farming drone project demonstrates how innovative technology can be made accessible to farmers, enhancing efficiency and sustainability in agriculture. By combining affordability with intelligent features, our solution empowers users to monitor crops and optimize resources. This project boosts productivity and proving that smart farming can be both practical and impactful.

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