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Development of an Agricultural Drone for Pesticide Spraying

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Abstract: ***Modern agriculture increasingly adopts unmanned aerial vehicles (UAVs) to enhance productivity and minimize human exposure to harmful chemicals. This research presents the design and development of a quadcopter-based drone equipped with a pesticide spraying system. The drone integrates brushless DC motors, electronic speed controllers, a flight controller, Li-Po battery, and a liquid spraying module. The proposed system aims to deliver efficient pesticide distribution while reducing labor and operational costs. Performance evaluation indicates that the developed drone produces adequate thrust to lift the payload and operate safely in agricultural environments.***
Keywords: Agricultural Drone, UAV, Quadcopter, Precision Agriculture, Pesticide Spraying

I. INTRODUCTION

Agriculture remains a major contributor to the economy and food security in developing nations. However, crop productivity is often affected by pests and diseases. Traditional pesticide spraying methods require significant human effort and expose farmers to hazardous chemicals. The introduction of UAV technology provides a modern solution to these challenges. Agricultural drones enable efficient spraying, monitoring, and data collection over large areas in a short time.

II. LITERATURE REVIEW

Several researchers have investigated UAV-based agricultural spraying systems. Studies demonstrate that drones can reduce chemical consumption, labor cost, and environmental impact. Various quadcopter configurations have been proposed to improve spraying efficiency and stability. Recent advancements also include sensor integration and automated flight control for precision farming.

III. SYSTEM DESIGN AND COMPONENTS

The developed quadcopter uses an F450 frame with four A2212 1400KV brushless motors and 10x4.5 propellers. Electronic speed controllers regulate the motor speed, while the flight controller stabilizes the aircraft using gyroscope and accelerometer sensors. A 3S 2200 mAh lithium polymer battery supplies power to the system. A DC pump connected to a liquid tank distributes pesticides through a nozzle.

A. Working

The signals will be transmitted from Transmitter and it will be received by the Receiver in the drone. From the receiver the signal goes to the Flight controller where the signal will be processed with accelerometer and gyroscope sensors. The processed signal will be sent to the ESC, which allows the specific amount of current to the motor based on the signal it receives. The propellers are mechanically coupled to the motors so that they rotate and produce thrust. The FPV camera takes current supply from the flight controller and it records the video, the video signals will be processed by the transmitter and it will be received by the receiver in ground. The pump takes current supply from the Li-Po battery and pressurizes the liquid from the storage tank then the pressurized liquid flows through the pipeline and enters the nozzle then gets sprayed. The flow rate of the pump can be controlled by varying the input current which can be controlled from the transmitter.

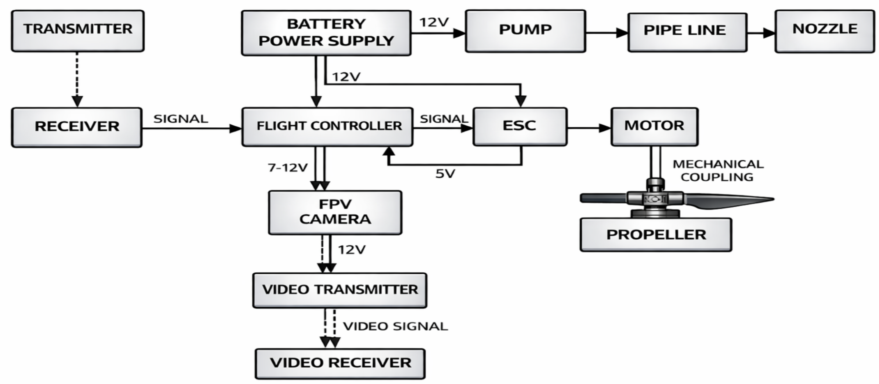

Fig -1: Block diaggram of working process

B. Components used

1) Motor

Outer runner BLDC motors in which there are no brushes, they have a permanent magnet. The RPM of the motor can be controlled by varying the input current. This motor T MOTOR MN 7005 KV115 and P24x7.2F propeller produces a maximum thrust of 4783 grams.

Fig -2: T-MOTOR MN 7005 KV115

2) Propeller

The propeller is of 24 inches length and has 7.2 inches pitch. It is made up of carbon fiber which possesses high strength to weight ratio when compared to the propellers made up of plastics.

Fig -3: T-MOTOR Propeller P24X7.2CF

3) ESC

It stands for Electronic Speed Controller and it is used to vary the Revolution Per Minute (RPM) of the motor. 60A rated ESC is used as per the motor and battery specifications.

Fig -4: Flame 60A HV

4) Battery

The battery that can be used is a Li-Po battery of 22000mAh capacity and 22.2 V. In this battery six Li-Po cells are connected in series (6x3.7=22.2V).

Fig -5: Li-Po battery

5) Flight Controller

The flight controller helps in the maneuvering operations and also it provides Auto level function. The accelerometer and gyroscope sensors in the Flight controller processes the signals from the receiver and gives the output to the ESC. The KK 2.1.5 Flight controller board can be used in the drone as it has inbuilt firmware. The features of this Flight controller board are much easier for calibration. It uses ATMEL Mega 644PA 8-bit AVR RISC-based microcontroller with 64K of memory.

Fig -6: KK 2.1.5 Multi-Rotor LCD Flight controller

6) Radio Transmitter and Receiver

2.4.6 Radio Transmitter and Receiver The Transmitter and receiver used are FlySky CT6B 2.4Ghz 6CH and FS-R6B respectively. This combination provides a range of about 1000 meters. This Transmitter and receiver provide upto 6 channel options.

Fig -7: Fly sky CT6B 2.4 6CH Transmitter and FS-R6B Receiver wS

7) FPV Camera and Transmitter

The camera that can be used is HD FPV camera 1200 TVL, it has 2.8mm Lens, auto/color/ black & white Day and night format.TS5828 32CH mini transmitter can be connected to the camera for transmission of video signals to receiver at ground.

Fig -8: FPV camera

Fig -9: Video Transmitter

5.8G UVC receiver is used to receive the video signals. It can be connected to the android mobile which has installed the GO FPV application in it.

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Fig -10: 5.8 UVC OTG Receiver

8) Pump and Nozzle

To pressurize the liquid a 12 V DC water pump can be used which has 2.5 L/min capacity can be used. Then the pressurized liquid enters the nozzle and gets sprayed. The nozzle that can be used is a flat fan type for spraying the liquid. Four nozzles are connected with ducts and they are palace at 45cm distance between each other.

Fig -11: Pump Fig -12: Flat fan Nozzle

C. Weight Build-up

Table -2: Components Weight Datasheet

PARTS	WEIGHT(grams)
Frame	2000(Approx)
Battery	1386
Motor(8)	1504
ESC(8)+ power distributer	588
Propeller	448
Flight Controller	20
Total	5976

The overall weight of the drone is calculated by adding the total weight of components and the weight of payload.

Overall weight = Payload + Weight of components
= 6750 + 5946 =
12,696 grams(approx.)

D. Thrust Calculation

Thrust developed at 100% RPM can be three times larger than the total weight of the drone so that the drone has better maneuverability and the drone can climb higher altitudes with higher rate of climb.

Thrust produced by one propeller with one motor= 4783 grams
Total thrust produced = 8 x 4783 = 38264 grams
Thrust to weight Ratio = Thrust produced / total weight of drone
= 38264 / 12696

E. Battery Drain Time Calculation

The Battery Drain time can be more than 10 minutes so that the drone drains the entire storage tank and it can be refilled for another serve. For a safer side, the battery drain time has to be calculated by considering the distance and time for the drone to return safely.

Table -3: Current Requirement Table

COMPONENT	CURRENT REQUIRED (Amp)
Motor	120
Receiver	0.1
Flight Controller	0.1
ESC(8)	0.8
Camera	0.32
FPV transmitter	0.31
Pump	5
Total	126.63

Current output from battery= 22000 MAh
Total current consumption of all components = 126.63 A
Battery endurance = current output from battery/ Total current consumption of all components
= 22000 MAh / 126.63A
= 22*60 / 126.63 A
= 10.42 MINS. (AT 100% THROTTLE)

IV. RESULTS AND DISCUSSION

The total weight of the quadcopter including spraying equipment is approximately 1.8 kg. With four motors producing combined thrust greater than the system weight, the drone maintains stable flight. Experimental evaluation confirms the feasibility of drone-based pesticide spraying for agricultural applications.

V. CONCLUSION

The developed UAV spraying system provides an efficient and safer alternative to manual pesticide spraying. The design demonstrates sufficient thrust, stability, and spraying capability. Future improvements may include GPS navigation, autonomous flight paths, and advanced sensors for crop monitoring.

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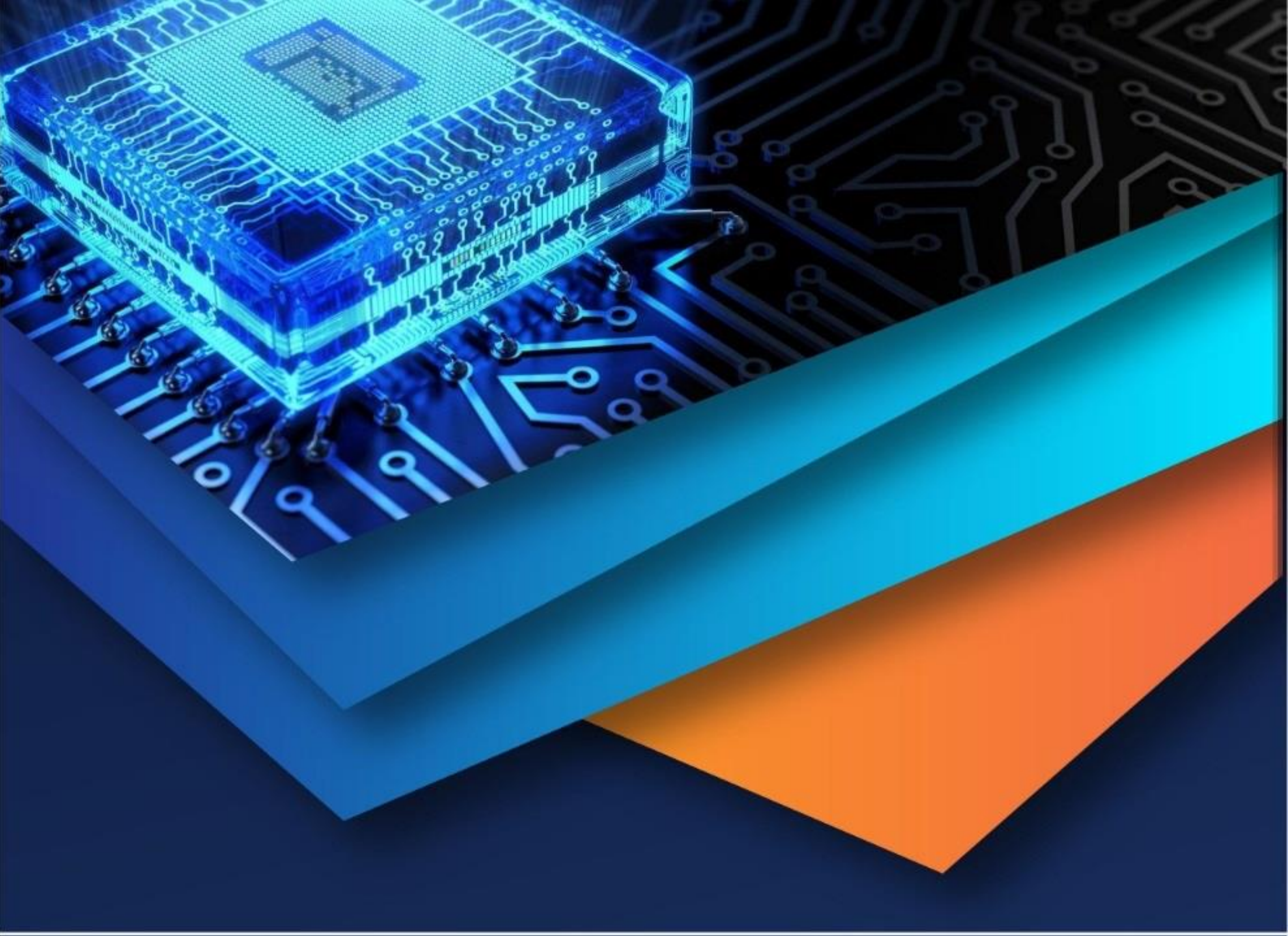

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