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Pesticide Spraying and Seed Sowing Quadcopter

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Abstract - *The main source of Indian economy is the Agriculture. But, currently agricultural field in India is facing some problem - the lack of human labors. There are some reasons like it requires hard work which causes tiredness and some field workers are migrating from the farm to other fields in the industry which offer them more stable and more profitable jobs. In this scenario, it becomes necessary to introduce and develop agricultural automation and sensing technologies to increase agricultural productivity. This project introduces a Quad copter that is also known as UAV i.e. Unmanned Aerial Vehicle wherein Quad copter is embedded with a pesticide spraying mechanism as well as a seed sowing mechanism. With this drone pesticides can be sprayed over a larger area and with minimal personnel and with high efficiency as well. The time required to complete this task is much faster than manual spraying and in this method there is no danger to the health of the worker. The building cost and maintenance cost is much lesser than the traditional spraying method and it is very easy to use also. With the innovative seed dropping mechanism, the Quad copter can fly over any terrain and target specific locations where there is no plant cover and drop thousands of seeds in that region, contributing to the re growth of plants in that terrain. This method is 10 times faster than manual labor that too at a fraction of the cost.*

Keywords

Pesticide spraying, Seed sowing, Flight control, Transmitter, Receiver, Electronic speed controller. Power Distribution Board

1. Introduction

The quadcopter was chosen for this project because of benefits like time saving operations & high stability. The quadcopter's control is easier while compared with the helicopter model or vehicles. Applications of quadcopter include Search and Rescue Emergency Management, Police, Code Enforcement/Inspections, Fire, Defense Surveillance, Border security, etc [1]. India and other developing countries are facing many problems in agriculture field like shortage of labor, health issues. Technology has developed interfaces that can control Unmanned Aerial Vehicle (UAV) by android application [2]. The handling of pesticides with direct physical contact can bring up medical problems. The health effects of pesticides include asthma, allergies and hypersensitivity, and pesticide exposure to cancer, hormone disruption and problems with reproduction and fetal development. Other pesticides may be irritated the skin and eyes. Therefore a usage of quadcopter will help in prevention of adverse health effects. With their small size and agile maneuverability, these quadcopters can be flown indoors as well as outdoors. Unlike most helicopters, quadcopters use 2 sets of identical fixed pitched propeller: 2 clockwise (CW) and 2 counter-clockwise (CCW). Along with the pesticide sprayer the another module in the quadcopter will contain a seed sowing mechanism. Seed sowing is one of the time consuming but most important task that needs to be done. So the need of modernization is very needed in this area. Quad copter being the unmanned aerial vehicle which will serve the purpose with greater efficiency. [3]

Initially Quad copter is assembled using necessary components such as Flight Controller Board (FCB), Brushless DC Motors, Electronic Speed Controller (ESC), Wireless Transceiver, Frame, Propellers and Battery etc. The Quad copter is entirely made on an aluminum frame with landing gears attached to it, for safe landing. Flight controller board is used for the functions of the drone such as movement, lifting, positioning, etc. ESC controls and regulates the speed of an electric motor. It is an electronic circuit which may also provide reversing of the motor and dynamic braking. The Quad copter is assembled with four brushless DC motors (350kV).[4] According to

the changes in the values of various sensors the speed of the motors can be varied to achieve required task. The Receiver used in this project consists of 6 channels with approximate 800mts.[4]

The spraying mechanism mainly consists of a tank of 500ml capacity to which a water pump is connected. To the outlet of this water pump a splitter is connected which spits the pesticide to two different outlets. At these outlets, the water enters two more T-splits from where it reaches the four nozzles which are connected at the opposite ends from where spraying is achieved. The mechanism will turn on by toggling the switch of channel 6 on the transmitter. On toggling, the receiver which is present on the aerial quad copter gives 5V to the step up voltage regulator, which brings the voltage to about 12V from where it is given to the relay. The relay gets triggered on receiving this volt and supplies current to drive the motor. Now the motor starts and pumps the water out of the nozzles. The drone can fly over any crop and spray pesticide over it by the help of this mechanism.

The mechanism which is going to be used is of the operator's choice. If the operator wants to spray pesticide over some crops then he can switch to pesticide spraying mechanism or if the operator wants to drop seeds over a rough terrain he can do so by fixing the seed sowing mechanism on the quad copter which is very easy to assemble.[2] Both of these mechanisms are detachable and also very easy to assemble back. The operator can remove these mechanisms and fly only the quad copter to improve his flight controls. These functions will be a lot easier if one understands or learns to control and fly a Quad copter.[4]

1.2 Objectives

The Main objectives include:

1. Design and fabrication of pesticide spraying mechanism that has a wide range of pesticide dispersal ability of about 1300 – 1500 sq.mtrs.
2. Design and fabricate a seed sowing mechanism which can sow the seed at different flow rates based on the size of the seed.
3. To spray pesticide and sow the seed effectively with least possible time.
4. To reduce the risk factor of the farmers like adverse effects on health, poisonous creatures etc.
5. To overcome the shortage of labours in the agriculture field and thereby also increase the productivity

2. Methodology

After deciding to create the Quadcopter, it was decided what electronics is to be used and which sensors we would incorporate into it. After a lot of research on the internet, we found a couple forums that discussed open source electronic and software components suitable for making a Quadcopter. Also, very basic but highly customizable Quadcopter bodies were available that were suitable for us to use to create our baseline system. We decided that we would use an aluminum frame and then build around it with the electronics that we wanted. We also got the motors and propellers. These components determined how much room we had for the electronics as well as how much weight we could put on the quadcopter and still have lift. The next thing we chose was the microcontroller which was an open source CC3D board which allowed us to put our own software on it. On the IMU Shield board there is a gyroscope, barometer, compass, and accelerometer which all need to work together to make sure the Quadcopter maintains stable flight while moving or hovering. Finally we purchased a Lithium-ion polymer (LiPo) battery because they have the best ratio of weight to power. The particular battery we chose has been sufficient to complete the design, assembly, and testing of the Quadcopter systems and our experiments have shown that since we have plenty of thrust we can chose a larger battery for our mission flights to improve the flight time. The basic Quadcopter design consists of four complete rotor assemblies attached at equal distances from each other and a central hub. All the rotors are located within the same plane and oriented such that the thrust generated by each rotor is perpendicular to the vehicle. If the rotors are comprised of parts with the same specifications and expected performance, each will produce the same amount of thrust given a specific power input.

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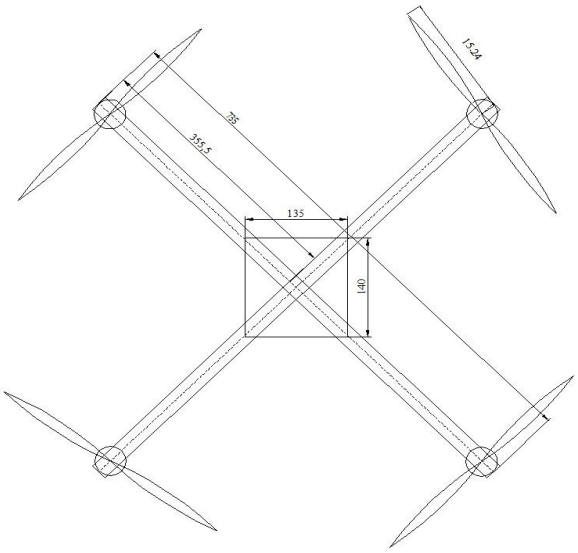
Fig 1 : Quadcopter setup

3. Design Specifications

The motors we used for the quadcopter are EMAX MT4008 (380kV)
it's maximum thrust is 1750g
So if I want to use 4 of these motors with (60 Amp ESC) to make a quadcopter so : 1750g*4 = 7000g
but as we know , if the total thrust is 7000g then it can lift the half (3500g) so that it fly great.
let me assume the total weight of the quadcopter is 1500g
thus it can lift : 3240g-1500g = 2000g
Thus, the quadcopter can lift up to 1.5 to 2 kg at max.



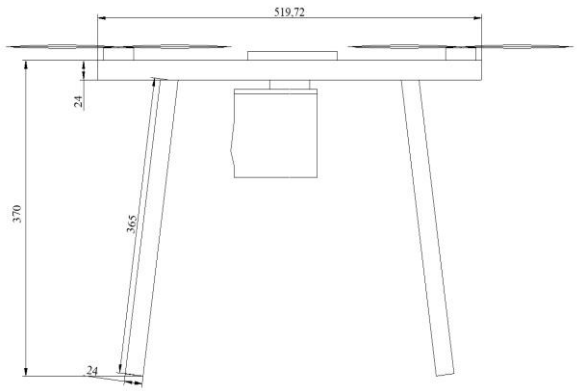


Fig 2 : Design of the frame

4. Specification of Design

4.1 Motor capacity:

This is a low power consumption motor for professional use. These are made with care keeping in mind weight and performance. The design is light weight with low CG with Japanese bearings. As they are disk type they allow air to flow in through the motor as to keep the motor cooler. With all this you will get much better flight time. Even the wires and the coils are from Japan. No compromise on quality.

4.2 Battery:

Most of the Batteries today are lithium based batteries because of how lightweight they are and has a higher charge density than typical Lead Acid and Nickel based batteries. Unfortunately these batteries are a little more expensive and in a few cases have dangerous side-effects but for the most part these batteries are more readily used.We are using a 4000mAh 22.2v battery for this project The battery will give us a flight time of approximately about 10-15 minutes.
Batteries are the heaviest item on a UAV so they are usually mounted on the dead center of the drone to subject the motors to the same load. Since batteries don't have their own mounting unit because screws that punctures the battery could cause a fire. Attaching the battery using Velcro has become popular because of its accessibility.
Propeller length:
For a low kV rate motors longer propellers are required. In our project we have used 12inch * 4.5 inch propellers

5. Components of Quad copter

This work was supported in part by a grant from the National Science Foundation.

5.1 Frame

The frame of a quadcopter is the main structure, or the skeleton upon which the rest of components will be attached. Once you have decided on what you want your craft to do (Aerial Photography, Racing, Micro Freestyle etc.), you need to decide what size best suits your requirements. The size of the frame will determine what size props you will use (or vice versa), in turn the size of the props will determine the size of the motors, which will specify the current rating of your ESC's.

When choosing a frame it is important to check that the mounting for the FC (Flight Controller) and the motors match your choice for these components.

5.2 Power Distribution Board (PDB)

PDB stands for Power Distribution Board and it is often where the battery power lead (ie. XT60) is connected. As its name suggests, the PDB distributes power to the components at the voltages they require. These days the necessity of using a PDB is being negated by FC's, ESC's and other (dubbed AIO or All-In-One) components providing the same function. These components have a wide input voltage range and can be connected to battery voltage (aka VBAT), they can then output a stable voltage ie. 5v to power an FPV camera or other components.

5.3 Flight Controller

The Flight Controller (aka "FC") is the brain of a quadcopter, it has sensors on the board so it can understand how the craft is moving. Using the data provided by these sensors, the FC uses algorithms to calculate how fast each motor should be spinning for the craft to behave as the pilot is instructing via stick inputs on the TX (Radio Transmitter). Most of the wiring on your quad will be focussed around the FC. It needs to have the RX (receiver) connected, so it can be told what the pilot wants the craft to do. Each of the ESC signal and ground wires need to be connected for the FC commands to be carried out by the motors. With the introduction of BetaFlight OSD (On Screen Display), even the video feed from the FPV camera goes via the FC to the VTX (Video Transmitter).

Fig 3: Flight Controller

5.4 Radio Receiver (RX)

Transmitters (TX) and receivers (RX) are not universal and you need to buy an RX that is compatible with your TX, an FrSky Taranis transmitter cannot work with a FlySky receiver. These days it is most likely that you will be using either PPM or a digital Serial protocol, which will only require 1 signal wire for all of the channels, plus power (3.3v or 5v) and GND. The signal wire will be connected to one of the UART terminals on your FC (Flight Controller). Some FC's actually have integrated receivers, if you are taking this route make sure that it is using a compatible protocol.

Fig 4 : Radio Receiver

5.5 Electronic Speed Controller (ESC)

An ESC is a device that interprets signals from the flight controller, and translates those signals into phased electrical pulses to determine the speed of a brushless motor. Make sure that both your FC and ESC's are capable of running the same ESC protocol ie. DShot 600. When selecting an ESC, remember that the current rating must be higher than the amperage drawn by your combination of motors and props.

These days an ESC has 4 input terminals, 2 are for signals coming from the FC. Signal and signal ground are wired to the FC, the 2 heavier wires are

for Positive and Negative, they carry the high current to the ESC to supply the motor. These Positive and negative are wired to the PDB. An ESC has 3 output terminals, one for each of the wires of a brushless motor.

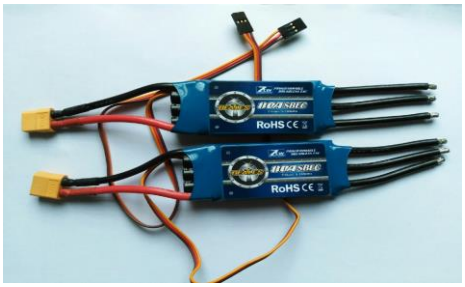


Fig 5 : Electronic Speed Controller (ESC)

5.6 Motors

The motors are the main drain of battery power on your quad, therefore getting an efficient combination of propeller and motor is very important. Motor speed is rated in kV, generally a lower kV motor will produce more torque and a higher kV will spin faster, this however is without the prop attached.

There are many aspects to motor performance aside from raw thrust, high among these is how much current the motor draws from the battery. Remember to check the specs of your motors for their maximum amp draw, and ensure that your ESC's are rated to withstand this amperage.

Fig 6 : Motor

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5.7 Propellers

There are possibly thousands of different types of propeller for quadcopters, with multiple options in almost every size. A heavier propeller will require more torque from the motor than a lighter prop, also blades with a higher AOA (Angle Of Attack – aka "aggressive props") encounter more resistance from the air and require more torque. When a motor has to work hard to turn, it draws more Amps. Finding a balance between the thrust produced and the amperage used by the prop and motor combination is a balancing act that every quad pilot goes through, there is no "right answer".

Fig 7 : Propellers

5.8 Transmitter(TX)

The Avionic RCB6i has all the features and more than any high end radio but at a fraction of cost. Some of the unique features of this radio are Interchangeable from mode 1 to mode 2 with the use of a slider at the back of the radio, remote range test (no need to walk a kilometer to find out the range of a receiver) and variable transmission power (for indoor and outdoor).

Fig 8 : Transmitter (TX)

5.9 Battery

LiPo batteries are the power sources of the quadcopters. LiPo is used because of the high energy density and high discharge rate. LiPo batteries are rated by their nominal voltage (3.7v per cell), cell count in series, (shown as a number followed by 'S') ie 4S = 14.8v, capacity in mAh (ie.1300mAh) and discharge rate or 'C' rating (ie. 75C). A lot of battery types can be fully discharged, but the LiPos have a minimum voltage requirements, which if gone beyond can cause damage to the battery

In this project it require a 24V Li-Po battery for the efficient flight time of the drone and due to the unavailability, two 12V batteries are used and

then connected them in series. For achieving this connector are made which when connected to the batteries, they get connected in series configuration.

Fig 9 : Batteries

5.10 Pesticide sprayer & seed sower mechanisms

The sole purpose for this component is to store and give out the pesticide or seeds. This container is fixed under the drone. The pesticide or seeds are filled in a container before take-off so that it can spray the pesticide or drop the seeds aerially wherever required.

Fig 10 : Pesticide Container

Fig 11 : Seed sowing mechanism

6. Advantages

- Can carry a payload upto 1.5 to 2 kg.
- Pesticide spraying operation can be replaced with seed sowing by interchanging the arrangement.
- Can replace the traditional time consuming field operations.

7. Limitations

- The biggest drawback is the range constraint of the quadcopter to operate due to battery issues.
- Very difficult to control the quadcopter using remote and hence requires an experienced person.

8. Conclusion

The overall possible outcome of the project is briefed as follows:

- Basically, from the overall project it is sure that it is going to help the society, especially the farmers in their agricultural lands.
- The project is estimated to serve as a multi utility quadcopter which is used for more than one purpose with the least possible cost.
- Pesticide sprayer and seed sower can together help a farmer to get rid of the labour shortage problems in a great way.
- Even though there is periodic works for the farmer to change the system for different jobs and again charging still it feels economical than the traditional labour system.

- Thus, if the project can be a successful product then it can be one of the market leaders in the field of agriculture.

9. Result & Discussion

The quad copter can lift up to 1.5 to 2 kg at max This is because of the light weight frame which was made of aluminium.The weight ligting capacity of the quad copter can be increased by choosing higher specification of BLDC motor. The quad copter gave up the expected thrust enough to provide an elevation of 10 feets. It can give an operative flight time of 15 minutes. To increase the flight time a higher specification of LiPO batteries are recommended. The area covered is around 5500 sq.mtrs.

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