Visvesvaraya Technological University, Belagavi.

PROJECT REPORT

on

"IOT-Based Drone for Improvement of Crop Quality in Agricultural Field"

Project Report submitted in partial fulfillment of the requirement for the award of the degree of

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CERTIFICATE

This is to Certify that the dissertation work **"IOT-Based Drone for Improvement of Crop Quality in Agricultural Field"** carried out by Chaitanya Krishna RS (1CR15EC044), Akshith Krishnan (1CR15EC013), Madhu MS (1CR17EC413), bonafide students of **CMRIT** in partial fulfillment for the award of **Bachelor of Engineering** in **Electronics and Communication Engineering** of the **Visvesvaraya Technological University, Belagavi,** during the academic year **2019-20**. It is certified that all corrections/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 requirements in respect of Project work prescribed for the said degree.

Signature of Guide	Signature of HOD	Signature of Principal
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ABSTRACT

Unmanned Aerial Vehicles are becoming more and more popular to meet the demands of increased population and agriculture. Drones equipped with appropriate cameras, sensors and integrating modules will help in achieving easy, efficient, precision agriculture. The proposed solutions related to these drones, if integrated with various Machine Learning and Internet of Things concepts, can help in increasing the scope of further improvement. In this paper, the related work in this field has been highlighted along with proposed solutions that can be integrated into the drone using Arduino Uno.

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Chapter 1

INTRODUCTION

Unmanned Aerial Vehicles (UAV) have been in use since 1980 and their applications are expanding rapidly. To meet the demand of increased population and food production, the drone in agriculture is a viable solution due to their increased accuracy, efficiency and ability to overcome various obstacles that traditional machinery cannot and will improve this industry greatly through accurate measurements, real-time data gathering, and efficient crop management. As IoT (Internet of Things) becomes more commercialized, various IoT concepts can be integrated into agriculture drones to help improve agriculture industry. Drones are easier to use, efficient and can be operated by farmers to gather accurate, real-time data. By localization, mapping and analysis of high- resolution images captured by the drone, more efficient crop management can be made possible. In this paper, the related works of similar drones have been highlighted along with possible solutions. Using the most efficient and compatible technology, a few proposed solutions have been mentioned which can be integrated with Arduino uno to provide better drones for agriculture. Satellite images are used for applications such as the identifying sparse shrub lands and grasslands for desertification monitoring with an accuracy of 79% and 66% respectively. However, to satisfy the need for precision agriculture, the drones must be used. The drones provide precise ground truth information, more accurate

images as they are closer to the ground. By using drones, we can adjust and measure the distance from terrain, calculate depth level, measure water stress level of crops, physiological features of crops and many more applications. Thus, a drone properly equipped with adequate tools and technology can make efficient, precision agriculture possible.

1.1 Problem Definition

To develop an unmanned aerial vehicle which can be used for the improvement of crop quality in agricultural fields

1.2 Objective

1. To develop a self-sustaining device to ensure the crop quality on agricultural field of large area.
2. Develop a manually controlled UAV device with a pesticide spraying mechanism equipped which can be controlled by a person from the ground.
3. To record the information of all the data from the agricultural drone like the area where the pesticide was sprayed on the field at a particular time or day and store the information in the cloud provided by the IoT platform which can be accessed using a phone
4. To provide a customizable user interface for easier operation.
5. To avoid any risks of injuries or death to the farmers

Chapter 2

LITERATURE SURVEY

Deepak Murugan et al. have proposed an approach for precision agriculture monitoring.It helps to distinguish between a sparse and a dense field using available data from the satellite and the drone. This approach works with image statistics of a region and helps to minimize drone activity. [2]

Paolo Tripicchio et al. have stressed on the popularity of drones used in agriculture. With the help of an RGB-D sensor connected to the drone, various ploughing techniques can be distinguished. Two different algorithms are used to differentiate between the ploughing fields. [3]

Rodrigo Filev Maia et al. have discussed about an IoT device which is used to monitor various agricultural parameters. The device uses a network of sensors for measuring the soil temperature, humidity, moisture etc. The test was carried out in Sao Paulo, Brazil. Reference climate data was taken to support various decisions on crop life and its sustainability. [4]

Marthinus Reinecke et al. have proposed the usage of drones for the betterment of crop quality. This could help the farmers increase their production by detecting the loopholes beforehand. The crops could be managed by using specificcameras connected to the drones to detect water shortages and harmful pests. [9]

Floriano De Rango e.t. al have proposed the usage of a simulator that is suited to the agricultural fields. This simulator would coordinate with the UAV and control the activity of the UAV in the presence of harmful insects in the crops. It would also consider various other parameters like energy and the communication range of the drones. [10]

D. Yallappa et al have proposed the design of a drone which would be helpful for spraying necessary chemicals on crops. This helps reduce the cost of pesticide application. The proposed sprayer is said to consist of 6 BLDC motors. A 5L capacity conical chamber was used to hold the pesticide solution. A DC motor coupled with a pump was used to pressurize the solution into fine droplets by means of four nozzles. The entire process was controlled with the help of a transmitter at ground level. A camera was used to monitor the live spraying operation.[11]

Chapter 3

PRE- REQUISITES

3.1 Quadcopter

A quadcopter, also called a quadrotor helicopter or quadrotor, is a multirotor helicopter that is lifted and propelled by four rotors. Quadcopters are classified as rotorcraft, as opposed to fixed-wing aircraft, because their lift is generated by a set of rotors (vertically oriented propellers).

Quadcopters generally use two pairs of identical fixed pitched propellers; two clockwise (CW) and two counterclockwise (CCW). These use independent variation of the speed of each rotor to achieve control. By changing the speed of each rotor it is possible to specifically generate a desired total thrust; to locate for the centre of thrust both laterally and longitudinally; and to create a desired total torque, or turning force.

Figure 1:Drone

Quadcopters differ from conventional helicopters, which use rotors that are able to vary the pitch of their blades dynamically as they move around the rotor hub.

In the early days of flight, quadcopters (then referred to either as 'quadrotors' or simply as 'helicopters') were seen as possible solutions to some of the persistent problems in vertical flight. Torque-induced control issues (as well as efficiency issues originating from the tail rotor, which generates no useful lift) can be eliminated by counter-rotation, and the relatively short blades are much easier to construct. A number of manned designs appeared in the 1920s and 1930s. These vehicles were among the first successful heavier-than-air vertical takeoff and landing (VTOL) vehicles. However, early prototypes suffered from poor performance, and latter prototypes required too much pilot work load, due to poor stability augmentation and limited control authority.

In the late 2000s, advances in electronics allowed the production of cheap lightweight flight controllers, accelerometers (IMU), global positioning system and cameras. This resulted in the quadcopter configuration becoming popular for small unmanned aerial vehicles. With their small size and maneuverability, these quadcopters can be flown indoors as well as outdoors.

At a small size, quadcopters are cheaper and more durable than conventional helicopters due to their mechanical simplicity. Their smaller blades are also advantageous because they possess less kinetic energy, reducing their ability to cause damage. For small-scale quadcopters, this makes the vehicles safer for close interaction. It is also possible to fit quadcopters with guards that enclose the rotors, further reducing the potential for damage. However, as size increases, fixed propeller quadcopters develop disadvantages relative to conventional helicopters. Increasing blade size increases their momentum. This means that changes in blade speed take longer, which negatively impacts control. Helicopters do not experience this problem as increasing the size of the rotor disk does not significantly impact the ability to control blade pitch. Due to their ease of construction and control, quadcopter aircraft are frequently used as amateur model aircraft projects.

3.1.1 Quadcopter Components

Frame

Figure 2:Frame

Every quadcopter or other multirotor aircraft needs a frame to house all the other components. Things to consider here are weight, size, and materials. We recommend the DJI FlameWheel F450 or one of the many clones. These are great quadcopter frames. Check out our review of the FlameWheel F450 here. They're strong, light, and have a sensible configuration including a built-in power distribution board (PDB) that allows for a clean and easy build. There are also a ton of spare parts and accessories available from many different websites. There are also a ton of clones out there, most of which include the same built-in PDB and durable construction as the original. Parts and accessories are 100% compatible and interchangeable.

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 i.e. 5v to power an FPV camera or other components.

Flight Controller

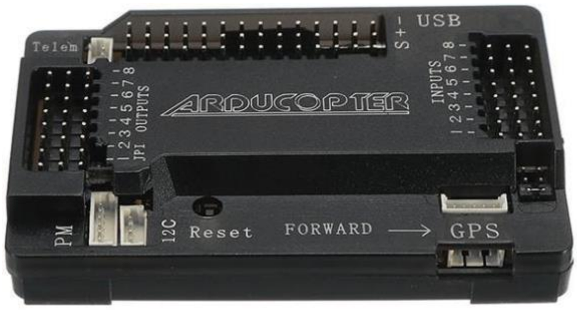


Figure 3:Flight Controller

The flight control board is the 'brain' of the quadcopter. It houses the sensors such as gyroscopes and accelerometers that determine how fast each of the quadcopter's motors spin. Flight control boards range from simple to highly complex. A great flight control board for first time quadcopter builders is the HobbyKing KK2.0. It is affordable, easy to set up, and has strong functionality. It can handle just about any type of multirotor aircraft so if you later want to upgrade to a hexacopter or experiment with a tricopter, you won't need to purchase another board. Update: There is a newer version of the KK flight control board – the KK2.1.5. Howeever we make use of Arducopter 2.8 Flight Controller which works similar to the KK2.1.5.

Radio Transmitter and Receiver

Figure 4:Fly Sky FS-CT6B CT6B 2.4G 6CH Radio Transmitter+FS-R6B 6CH Receiver

The radio transmitter and receiver allow you to control the quadcopter. There are many suitable models available, but you will need at least four channels for a basic quadcopter with the KK2.0 control board. We recommend using a radio with 8 channels, so there is more flexibility for later projects that may require more channels. The Turnigy 9x is a great choice for a first radio. It’s inexpensive yet still has some advanced functionality. There is also a large community of 9x users out there, so troubleshooting is easier. Chances are any problem you have has been experienced and solved before, or someone on a forum like rcgroups will be able to help you out. Update: there is a newer model of this radio out – the Turnigy 9xR pro. However due to the avaibility issues we make of FlySky FS-CT6B CT6B 2.4G 6CH Radio Transmitter+FS-R6B 6CH Receiver.

ESC – Electronic Speed Controller

The electronic speed control, or ESC, is what tells the motors how fast to spin at any given time. You need four ESCs for a quadcopter, one connected to each motor. The ESCs are then connected directly to the battery through either a wiring harness or power distribution board. Many ESCs come with a built in battery eliminator circuit (BEC), which allows you to power things like your flight control board and radio receiver without connecting them directly to the battery. Because the motors on a quadcopter must all spin at precise speeds to achieve accurate flight, the ESC is very important. These days if you are building a quadcopter or other multirotor, it is pretty much standard to use ESCs that have the SimonK firmware on them. This firmware changes the refresh rate of the ESC so the motors get many more instructions per second from the ESC, thus have greater control over the quadcopter's behavior. Many companies sell ESCs that have the SimonK firmware already installed.

Figure 5: Simonek Electronic Speed Controller

Motors

The motors have an obvious purpose: to spin the propellers. There are tons of motors on the market suitable for quadcopters, and usually you don't want to get the absolute cheapest motors available, but you also don't want to break the bank when some reasonably priced motors will suffice. Motors are rated by kilovolts and the higher the kV rating, the faster the motor spins at a constant voltage. When purchasing motors, most websites will indicate how many amps the ESC you pair it with should be and the size of propeller you should use. We have found that a 1000kV motor is a good size to start with.

Figure 6:1000kV Brush-less DC Motor

Propellers

A quadcopter has four propellers, two "normal" propellers that spin counter-clockwise, and two "pusher" propellers that spin clockwise. The pusher propellers will usually be labeled with an 'R' after the size. For the quadcopter configuration in this post, we're using 9×4.7 props. This is a good size for the motors and ESCs we're using. Propellers are available at a lot of websites.

Figure 7:Propellers 9*4.7

Battery

Quadcopters typically use LiPo batteries which come in a variety of sizes and configurations. We typically use a 3S1P battery, which indicates 3 cells in parallel. Each cell is 3.7 volts, so this battery is rated at 11.1 volts. LiPo batteries also have a C rating and a power rating in mAh (which stands for milliamps per hour). The C rating describes the rate at which power can be drawn from the battery, and the power rating describes how much power the battery can supply. Larger batteries weigh more so there is always a tradeoff between flight duration and total weight. A general rule of thumb is that doubling the battery power will get you 50% more flight time, assuming your quadcopter can lift the additional weight. For this quadcopter, we suggest a 3000mAh LiPo like this one.

Figure 8:3000mAh Li-Po Battery

Battery Charger

Charging LiPos is a complex process, because there are usually multiple cells within the battery that must be charged and discharged at the same rate. Therefore you must have a balance charger. There are many chargers on the market that will do the job, but be careful of cheap or off-brand chargers as many of them have faulty components and can cause explosions or fires. In general you should absolutely never leave LiPo batteries charging unattended. Many people charge batteries outside on a cement area or in a fireproof LiPo bag (although the effectiveness of these is up for debate). We recommend the IMAX B6 AC Balance Charger. It is affordable but reliable. Be wary of knock-offs.

Figure 9:B-3 Battery Charger

3.1.2 Quadcopter Controls

When learning how to fly a quadcopter, the controls will become our bread and butter.

They will become second nature once we know how they act individually and how they interact together to form a complete flying experience.

There are four main quadcopter controls:

1. Roll
2. Pitch
3. Yaw
4. Throttle

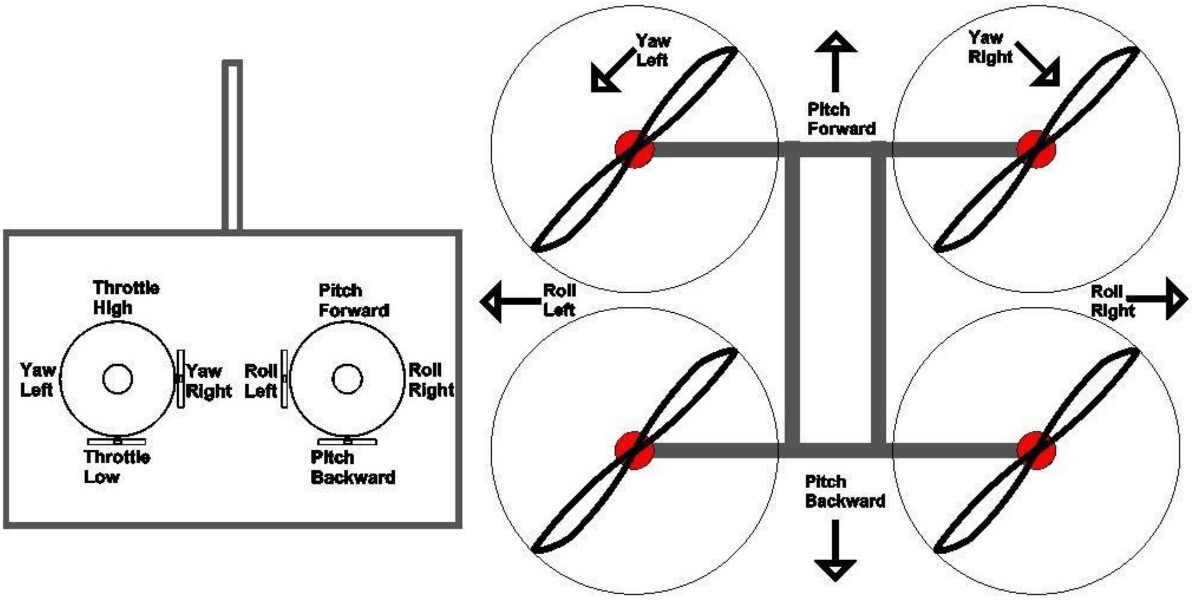


Figure 10: Simple sketch of roll, pitch, yaw, and throttle on a transmitter (left image) and quadcopter (right image).

Roll

Roll moves your quadcopter left or right. It’s done by pushing the right stick on your transmitter to the left or to the right.

It’s called “roll” because it literally rolls the quadcopter.

For example, as you push the right stick to the right, the quadcopter will angle diagonally downwards to the right.

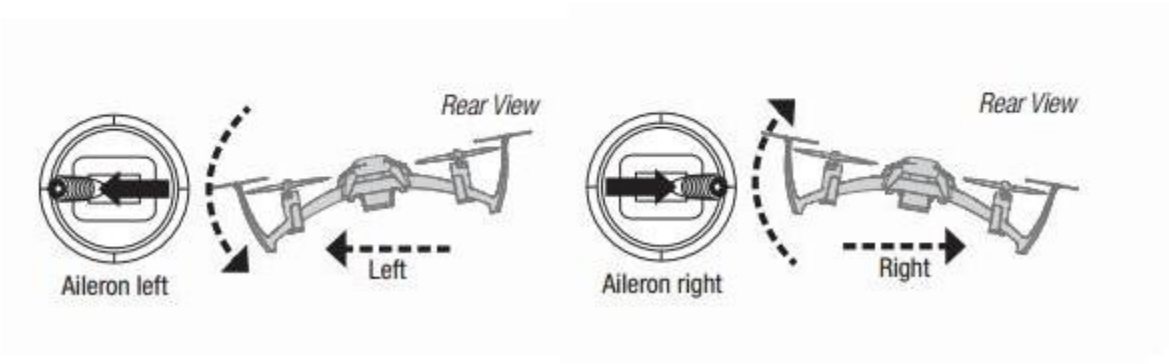


Figure 11: Example of a quadcopter rolling left and right. Notice the tilt of the quadcopter and the angle of the propellers.

Here, the bottom of the propellers will be facing to the left. This pushes air to the left, forcing the quadcopter to fly to the right.

The same thing happens when you push the stick to the left, except now the propellers will be pushing air to the right, forcing the copter to fly to the left.

Pitch

Pitch is done by pushing the right stick on your transmitter forwards or backwards. This will tilt the quadcopter, resulting in forwards or backwards movement.

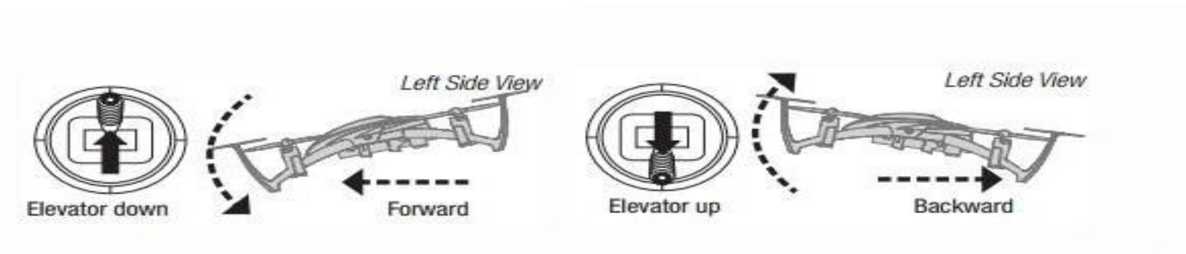


Figure 12:Example of a quadcopter pitching forwards and backwards. Note that this view is from the left side.

Yaw

Yaw was a little bit confusing for me in the beginning. Essentially, it rotates the quadcopter clockwise or counterclockwise.

This is done by pushing the left stick to the left or to the right.

Yaw is typically used at the same time as throttle during continuous flight. This allows the pilot to make circles and patterns. It also allows videographers and photographers to follow objects that might be changing directions.

Throttle

Throttle gives the propellers on your quadcopter enough power to get airborne. When flying, you will have the throttle engaged constantly.

To engage the throttle, push the left stick forwards. To disengage, pull it backwards.

Make sure not to disengage completely until you're a couple inches away from the ground. Otherwise, you might damage the quadcopter, and your training will be cut short.

3.1.3 Pre-Flight Check list

Weather & Site Safety Check

1. Chance of precipitation less than 10%
2. Wind speed under 15 knots (less than 20 mph)
3. Cloud base at least 500 feet
4. Visibility at least 3 statute miles (SM)
5. If flying at dawn / dusk, double-check civil twilight hours
6. Establish take-off, landing, and emergency hover zones
7. Potential for electromagnetic interference?
8. Look for towers, wires, buildings, trees, or other obstructions
9. Look for pedestrians and/or animals and set up safety perimeter if needed
10. Discuss flight mission with other crew members if present

Visual Aircraft / System Inspection

1. Look for abnormalities—aircraft frame, propellers, motors, undercarriage
2. Look for abnormalities—gimbal, camera, transmitter, payloads, etc.
3. Gimbal clamp and lens caps are removed
4. Clean lens with microfiber cloth
5. Attach propellers, battery/fuel source, and insert SD card / lens filters

Powering Up

1. Turn on transmitter / remote control and open up DJI Go 4 app
2. Turn on aircraft
3. Verify established connection between transmitter and aircraft
4. Position antennas on transmitter toward the sky
5. Verify display panel / FPV screen is functioning properly
6. Calibrate Inertial Measurement Unit (IMU) as needed
7. Calibrate compass before every flight
8. Verify battery / fuel levels on both transmitter and aircraft
9. Verify that the UAS has acquired GPS location from at least six satellites

Taking Off

1. Take-off to eye-level altitude for about 10-15 seconds
2. Look for any imbalances or irregularities
3. Listen for abnormal sounds
4. Pitch, roll, and yaw to test control response and sensitivity
5. Check for electromagnetic interference or other software warnings
6. Do one final check to secure safety of flight operations area
7. Proceed with flight mission.

3.1.4 Important Safety Precautions

1. If you’re about to crash into something, turn the throttle down to zero, so you don’t potentially destroy your quadcopter, injure somebody, or injure yourself.
2. Keep your fingers away from the propellers when they’re moving.

3. Unplug/take out the battery of the quad before doing any work on it. If it turns on accidentally and the propellers start spinning, you might have a tough time doing future flights with missing fingers.
4. If you're a beginner learning to fly indoors, tie the quadcopter down or surround it by a cage.

3.2 Hardware's & Components used in Agricultural Drone

1. Arduino Uno:

The arduino uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16Mhz ceramic resonator , a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

Figure 13: Arduino uno

2. MPU-6050

The InvenSense MPU-6050 sensor contains a MEMS accelerometer and a MEMS gyro in a single chip. It is very accurate, as it contains 16-bits analog to digital conversion hardware for each channel. Therefor it captures the x, y, and z channel at the same time. The sensor uses the I2C-bus to interface with the Arduino.

Figure 14: MPU-6050

3. Adafruit AMG8833 IR Thermal camera

Adafruit AMG8833 IR Thermal Camera Breakout is an 8x8 array of thermal sensors. It returns an array of 64 individual temperature readings over 12C when it is integrated with the Arduino Uno module. This can measure temperatures starting from 0°C to 80°C (32°F to 176°F) with an accuracy of +- 2.5°C (4.5°F). It can detect a human from a distance of up to 7 meters (23) feet.

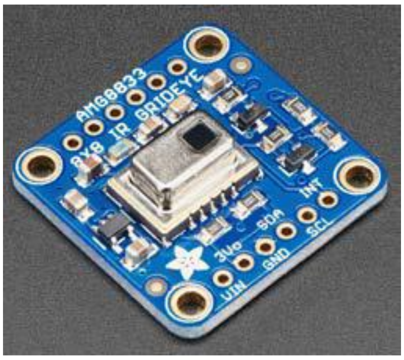


Figure 15: Thermal camera

4. RGB-D Sensor

RGB-D is a specific kind of depth sensing device (depth sensor), which works in association with an RGB camera. It adds to the conventional image, depth information, on a per pixel basis. An infrared sensor provides the depth data which is coordinated with a calibrated RGB camera. This produces an RGB image with a depth associated with each pixel. The IR projector emits predefined dotted patterns and the sidelong shift between the projector and the sensor marks a shift in the pattern dots which in turn determines the depth of the region being examined. An amalgamated representation of this data is the point cloud, which is a collection of points in three-dimensional space. Here every single point can have certain extra features, which in case of the RGB-D sensor is the colour.

This technology is licensed to be used in the commercially available sensors like the Asus Xtion PRO and Microsoft Kinect.

Figure 16: RGB-D Sensor

5. Submersible DC motor

A submersible pump (or sub pump, electric submersible pump (ESP)) is a device which has a hermetically sealed motor close-coupled to the pump body. The whole assembly is submerged in the fluid to be pumped. The main advantage of this type of pump is that it prevents pump cavitation, a problem associated with a high elevation difference between pump and the fluid surface. Submersible pumps push fluid to the surface as opposed to jet pumps which create a vacuum and rely upon atmospheric pressure. Submersibles use pressurized fluid from the surface to drive a hydraulic motor downhole, rather than an electric motor.

Figure 17: Submersible DC motor

6. Spraying Tank

This tank is fitted to the drone and is used to store the pesticide or other necessary chemicals in it which is supposed to be sprayed on to the crops when the drone is in flight

Figure 18: Spraying Tank of capacity 180mL

7. Zigbee Module

Zigbee is a low-cost, low-power, wireless mesh network standard targeted at battery-powered devices in wireless control and monitoring applications. Zigbee delivers low-latency communication. Zigbee chips are typically integrated with radios and with microcontrollers. Zigbee operates in the industrial, scientific and medical (ISM) radio bands: 2.4 GHz in most jurisdictions worldwide; though some devices also use 784 MHz in China, 868 MHz in Europe and 915 MHz in the US and Australia, however even those regions and countries still use 2.4 GHz for most commercial Zigbee devices for home use. Data rates vary from 20 kbit/s (868 MHz band) to 250 kbit/s (2.4 GHz band).

Figure 19: Zigbee Module

8. 8051 Microcontroller

A microcontroller (MCU for microcontroller unit) is a small computer on a single metal-oxide-semiconductor (MOS) integrated circuit (IC) chip. In modern terminology, it is similar to, but less sophisticated than, a system on a chip (SoC); a SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM. Microcontrollers are designed for embedded applications.

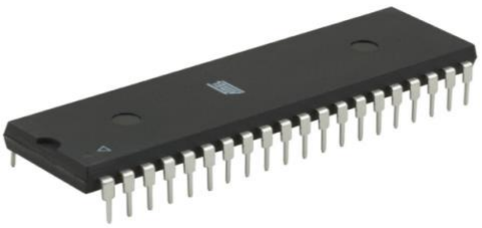


Figure 20: 8051 Microcontroller

9. Relay

A relay is an electrically operated switch. It consists of a set of input terminals for a single or multiple control signals, and a set of operating contact terminals. The switch may have any number of contacts in multiple contact forms, such as make contacts, break contacts, or combinations thereof. Relays are used where it is necessary to control a circuit by an independent low-power signal, or where several circuits must be controlled by one signal.

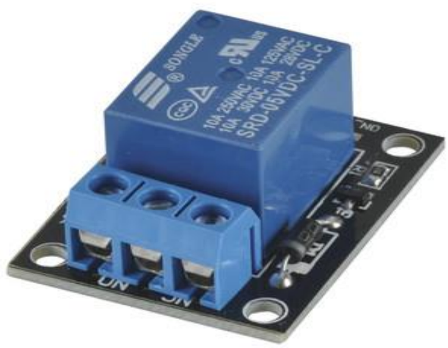


Figure 21: Relay

10. Nozzles

A nozzle is a device designed to control the direction or characteristics of a fluid flow (especially to increase velocity) as it exits (or enters) an enclosed chamber or pipe.

A nozzle is often a pipe or tube of varying cross sectional area, and it can be used to direct or modify the flow of a fluid (liquid or gas). Nozzles are frequently used to control the rate of flow, speed, direction, mass, shape, and/or the pressure of the stream that emerges from them. In a nozzle, the velocity of fluid increases at the expense of its pressure energy.

Figure 22: Nozzles

Chapter 4

METHODOLOGY: DRONE

4.1 Getting the drone off the Ground

To get the quadcopter in the air, the only control you need is the throttle.

Push the throttle (left stick) up very slowly, just to get the propellers going.

Then stop. Repeat this multiple times and until you're comfortable with the

throttle's sensitivity.

Slowly push the throttle further than before, until the copter lifts off the ground. Then pull the throttle back down to zero and let the quadcopter land.

Repeat this 3-5 times. Notice whether the copter is trying to rotate left or right (yaw), move left or right (roll), or move backwards or forwards (pitch).

If you notice any movements happening without you making them happen, use the corresponding trim button to balance them out.

For example, if you notice the copter moving to the left when you push the throttle, adjust the "roll" trim button next to the right stick.

Keep adjusting the trims until you get a relatively stable hover off the ground by only using the throttle.

4.2 Hovering in the Mid Air and Landing

To hover, you will use the throttle to get airborne. You will then use small adjustments of the right stick to keep the quadcopter hovering in place.

You may also need to adjust the left stick (yaw) slightly, to keep it

from turning. Use the throttle to get the copter about a foot to a foot-

and-a-half off the ground.

Make tiny adjustments with the right stick (and the left, if necessary) to keep the copter hovering in position.

When you're ready to land, cut back the throttle slowly.

When the quadcopter is an inch or two off the ground, go ahead and cut the throttle completely and let the UAV drop to the ground.

Repeat this until you get comfortable hovering off the ground and landing gently.

4.3 Flying your Drone Left, Right, Back and Forth

To fly a quadcopter left, right, forwards, and backwards, you will need to hold the throttle at a steady rate to keep it airborne. You will then use the right stick to maneuver the quadcopter in the direction you want it to go.

First, bring your copter to a hover.

Push the right stick forward to fly it a couple feet

forward. Pull the right stick back to bring it back to

its original position.

Now, move it further backwards a couple feet, and return it to its

original position. Push the right stick to the left to move your copter a

couple feet to the left.

Move it back to its original position, then fly it a couple feet to the right.

If it starts to rotate (yaw), adjust the left stick to the left or right to keep the copter facing the same direction.

4.4 Arducopter APM 2.8 Circuit

1. APM 2.8 is a revision of the APM that makes use of an external compass.
2. The APM 2.8 has no on board compass, and is optimized for vehicles where the compass should be placed as far from power and motor sources as possible to avoid magnetic interference.

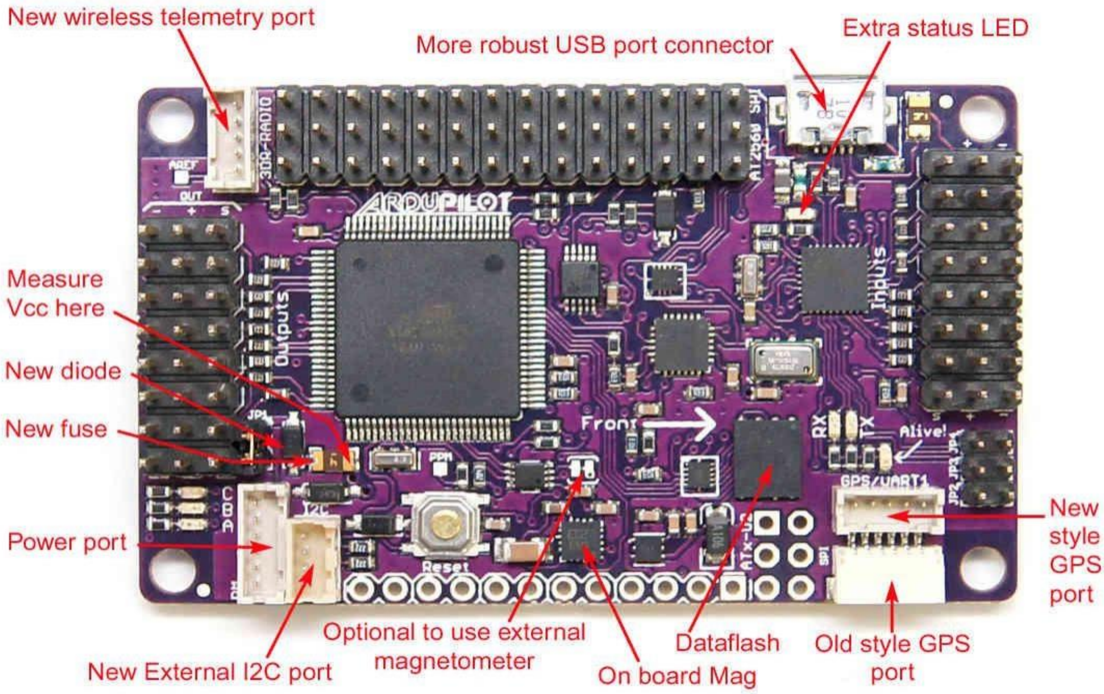


Figure 23:Arducopter APM 2.8 Pin Layout

3. APM 2.8 is designed to be used with the 3DR GPS uBlox LEA-6 with Compass module.
4. The GPS/Compass module may be mounted further from noise sources than the APM itself.
5. APM 2.8 requires a GPS unit with an on board compass for full autonomy.
6. For information on installing a 3DR GPS uBlox LEA-6 with Compass, visit 3DR Power Module.

4.5 Receiver Transmitter Circuits

The complete circuit Diagram including the Transmitter and Receiver part for this project is shown in the images below.

Below pictures showing the RF Transmitter Circuit:

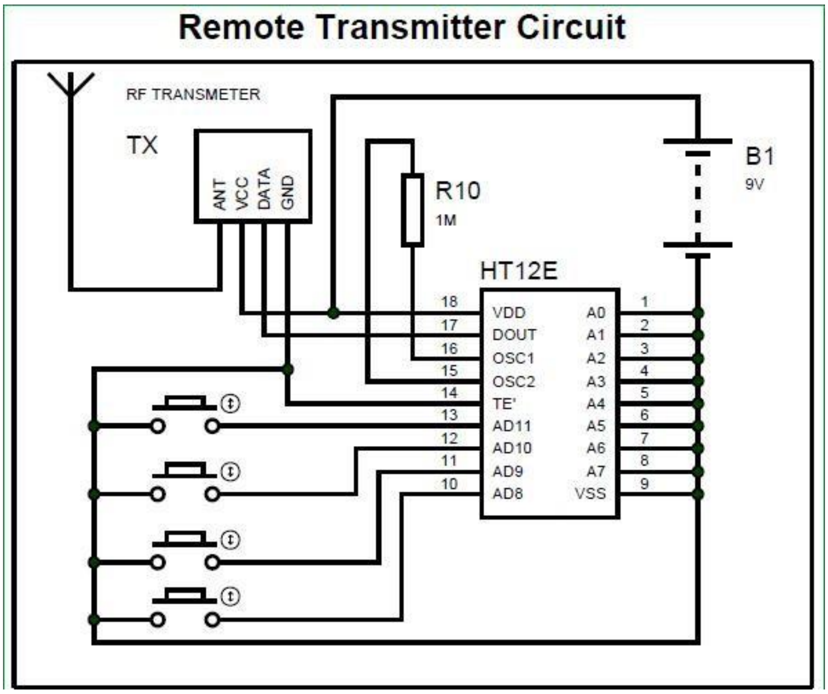


Figure 24:Remote Transmitter Circuit

And below ones showing the RF Receiver Circuit with Breadboard setup:

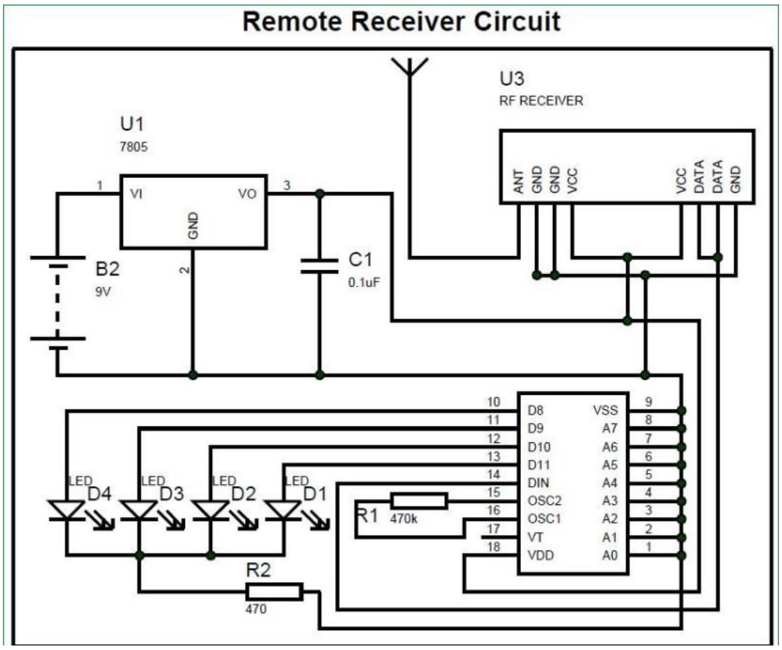


Figure 25:Remote Receiver Circuit

4.6 Brushless Motor Working

In a typical DC motor, there are permanent magnets on the outside and a spinning armature on the inside. The permanent magnets are stationary, so they are called the stator. The armature rotates, so it is called the rotor.

The armature contains an electromagnet. When you run electricity into this electromagnet, it creates a magnetic field in the armature that attracts and repels the magnets in the stator. So the armature spins through 180 degrees. To keep it spinning, you have to change the poles of the electromagnet. The brushes handle this change in polarity. They make contact with two spinning electrodes attached to the armature and flip the magnetic polarity of the electromagnet as it spins.

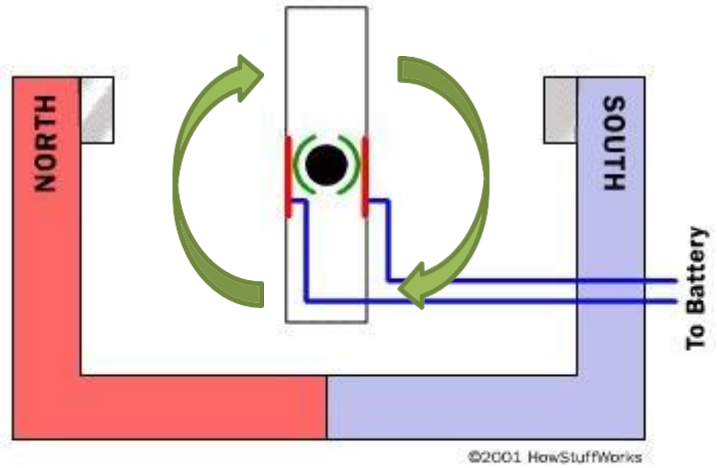


Figure 26:Motor Working Principle

This setup works and is simple and cheap to manufacture, but it has a lot of problems:

1. The brushes eventually wear out.
2. Because the brushes are making/breaking connections, you get sparking and electrical noise.
3. The brushes limit the maximum speed of the motor.
4. Having the electromagnet in the center of the motor makes it harder to cool.
5. The use of brushes puts a limit on how many poles the armature can have.

With the advent of cheap computers and power transistors, it became possible to "turn the motor inside out" and eliminate the brushes. In a brushless DC motor (BLDC), you put the permanent magnets on the rotor and you move the electromagnets to the stator. Then you use a computer (connected to high-power transistors) to charge up the electromagnets as the shaft turns. This system has all sorts of advantages:

1. A computer controls the motor instead of mechanical brushes, it's more precise. The computer can also factor the speed of the motor into the equation. This makes brushless motors more efficient.
2. There is no sparking and much less electrical noise.
3. There are no brushes to wear out.
4. With the electromagnets on the stator, they are very easy to cool.
5. You can have a lot of electromagnets on the stator for more precise control.

The only disadvantage of a brushless motor is its higher initial cost, but you can often recover that cost through the greater efficiency over the life of the motor.

Figure 27: Brush-less Motor Core and windings

4.7 Design of Drone

The drone chassis have been designed on CATIA V5 R20.

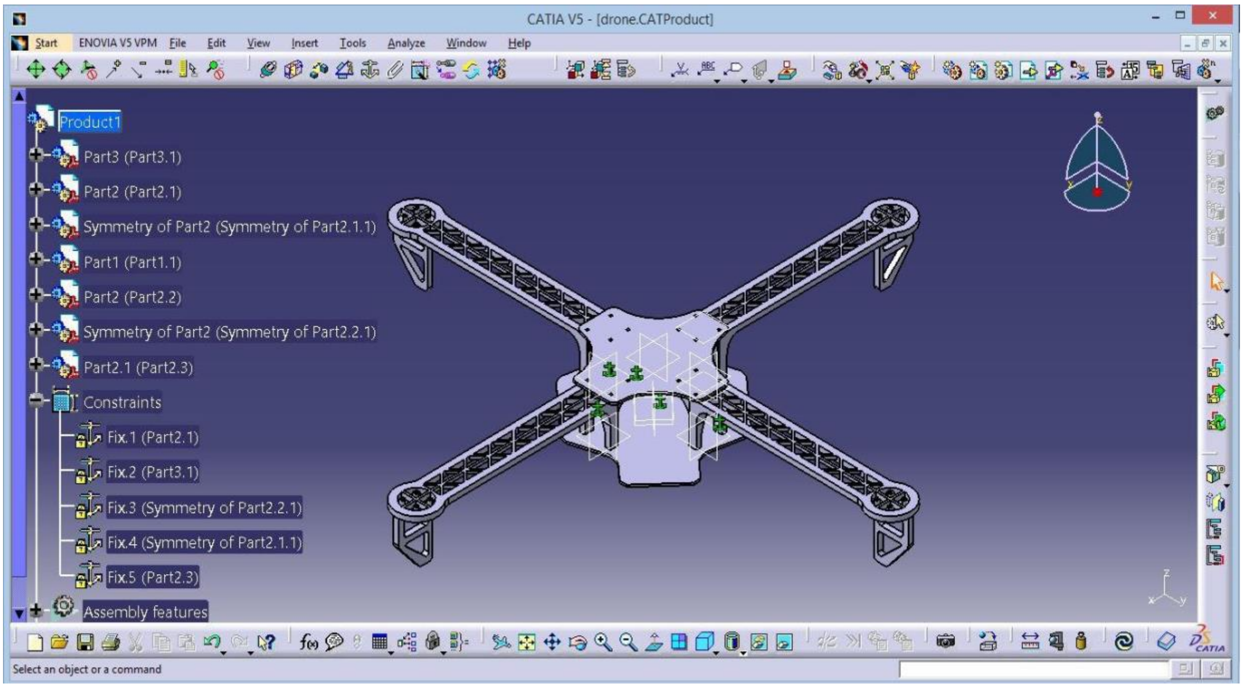


Figure 28: Drone Chassis

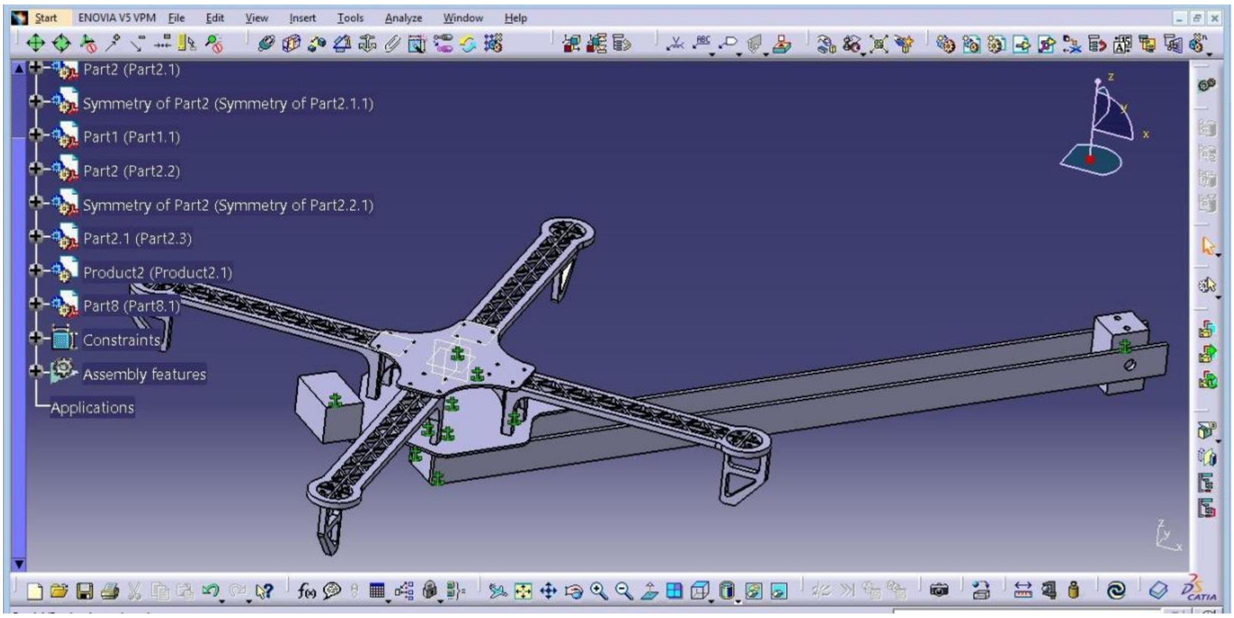


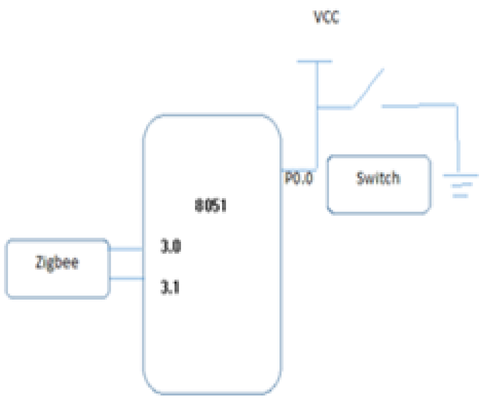
Figure 29: Full Assembly

CHAPTER-5

METHODOLOGY: SPRAYING MECHANISM

Figure 30 shows the block diagram of pesticide spraying mechanism to be integrated with quadcopter.

Transmitter side:



Receiver side:

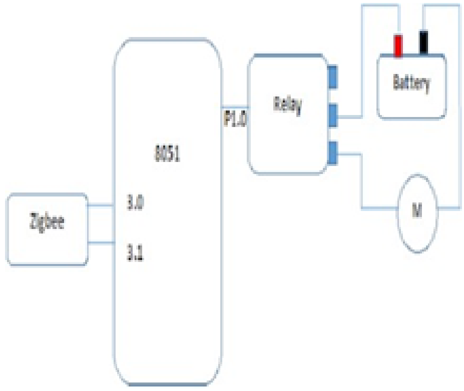


Figure 30: Block diagram of pesticide spraying module

For the pesticide spraying mechanism we use pesticide tank of capacity 180 ml, submersible dc motor pump, ZigBee module,8051microcontroller, relay, pipes fitted to T-split and mini nozzles. The working of spraying module is described in Figure 31

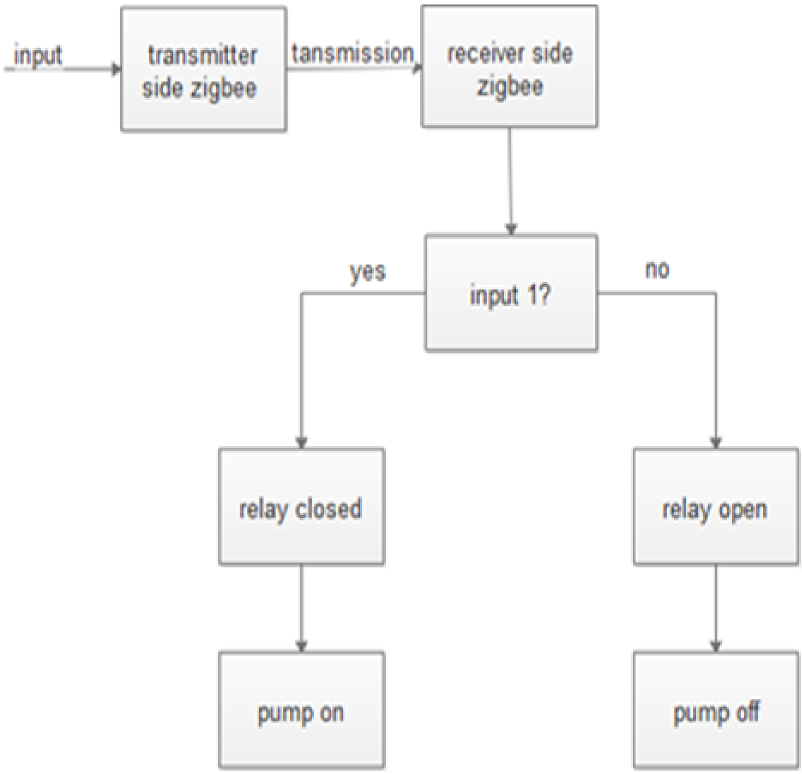


Figure 31: Working of spraying module

The input from the ground station microprocessor 8051 is transmitted to ZigBee module of transmitter side, which in turn transmits it to receiver side ZigBee and is passed onto 8051 microprocessor of receiver side. Depending on the input the relay remains open or closed. If the relay is open the pump is turned off else on.

CHAPTER- 6

CALIBRATION OF THE QUADCOPTER

Step 1: Downloading the Firmware

Figure 32: Adrucopter APM 2.8 Micro USB Port

1. Connect the flight controller to the computer system using the USB cable.
2. In Mission Planner, use the drop down menus in the upper-right corner of the screen (near the Connect button) to connect to APM. Select Arduino Mega 2560 and set the Baud rate to 115200 as shown. Don’t hit Connect just yet.

Figure 33: COM Port Selection

3. Select Initial Setup and select Install Firmware.
4. Now select which Firmware to download to APMa this depends on the configuration ofyour craft. Select the Hardware screen from the icons at the top of the display. Choose your copters frame by clicking the corresponding icon: Quad, Hexa, Y6, plane, rover, or other.
5. Once you select your frame, Mission Planner will automatically detect the latest firmware version for your craft and prompt you to confirm the download. Select Yes to download the firmware onto APM. When the download status reads Done, your Firmware download is complete.

Figure 34:Install Firmware-Step 1

Step 2: Accel Calibration

1. Click on the Connect option at right top corner.
2. Under Initial Setup, select Accel Calibration from the left-side menu.
3. Place the drone in front of you with the arrow on the flight controller pointing away.

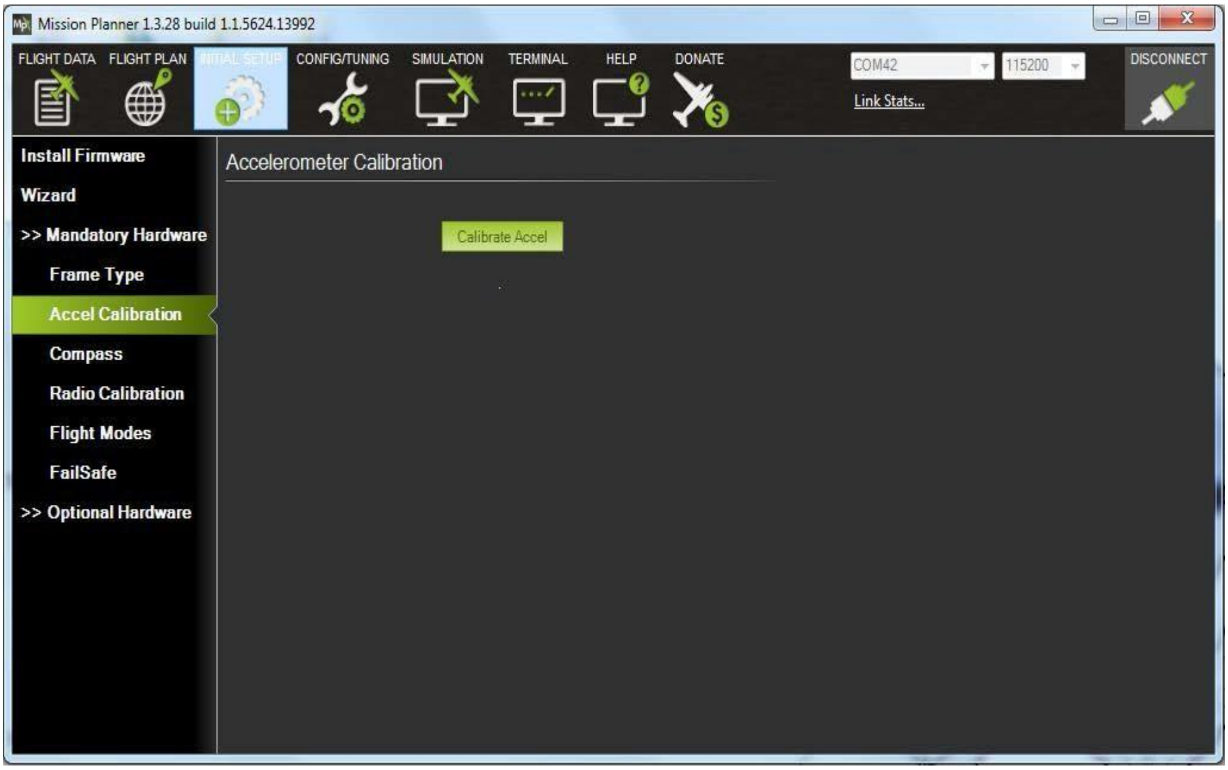


Figure 35: Accelerometer Calibration

4. Clicks calibrate and follow the on screen instructions.

Step 3: Calibrate Compass

Figure 36:Compass Calibration

1. Under initial Setup, select Mandatory Hardware select Compass. Select APM with External Compass.

2. Ensure the Enable and AutoDec check boxes are checked.
3. Click the Live Calibration button and follow the on screen instructions.
4. Move the craft in all directions making sure not to pull the data cable loose.
5. Continue to move craft until mission planner completes setup.

Step 4: Radio Calibration

1. In Mission Planner, click on the green "Calibrate Radio" button in the lower right of the window. Mission Planner will call a dialog window to ensure radio control equipment is on, battery is not connected, and propellers are not attached. Select OK.
2. Move the control sticks and toggle switches on your transmitter to their limits of travel and observe the results on the radio.
3. When the red bars for roll, pitch, throttle, yaw, and radio 5 (and optionally radio 6, 7 and 8) are set at the minimum and maximum positions, select click when done.

Figure 37: Radio Calibration

Step 5: PID Tuning

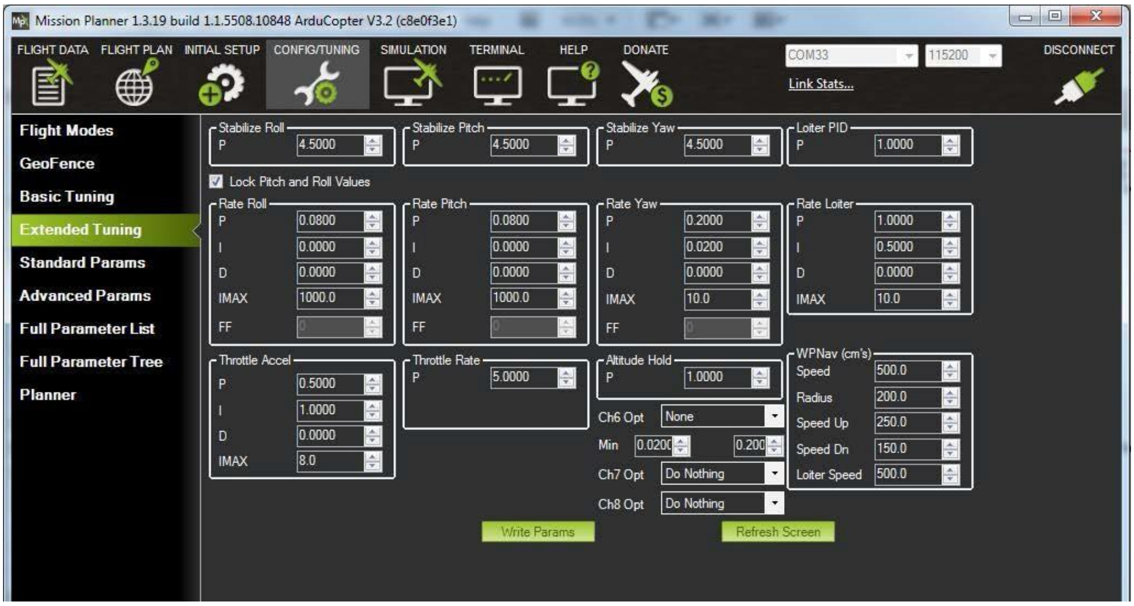


Figure 38:Extended PID Tuning Window

1. With the Multirotor mounted in the Test Rack, open the Mission Planner Software.
2. Click on the Config/Tuning, E tended Tuning. The screen should look like the one below.
3. You will need to adjust all of the tuning values to match the image below and then click the write Parameters button.

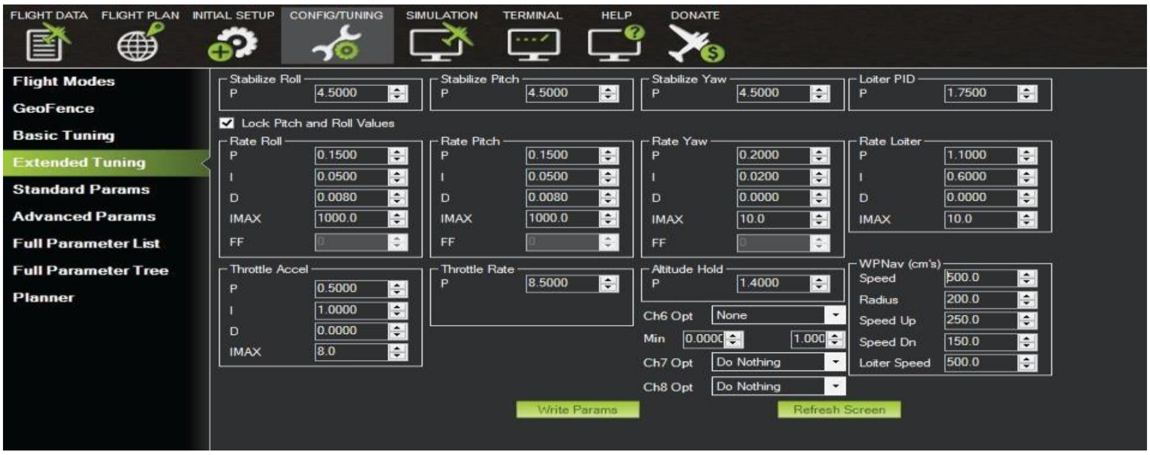


Figure 39:Extended Tuning Setting Parameters

Chapter 7

CALCULATIONS

Balancing-Static Thrust Calculation

From momentum theory, we have Power required to lift weight- PIND (Induced Power)

Mass flow rate $\dot{m} = \rho A \nu$

where ρ-density of media

ν- inflow over disk

A-CS area of disk

Momentum conservation $T=\dot{m}(w-0)$

where T-Thrust force

w- flow velocity downstream

$T=\rho A\nu * w$

Energy Conservation $T\nu= \frac{1}{2} \rho A\nu w^2$ [Power = Force * Velocity]

$w = 2\nu$

$T=2\rho A\nu^2$

From above equation, we get $\nu=\sqrt{T/2\rho A}$

$P_{IND} = T*\nu = T * \sqrt{T/2\rho A}$

For 1 kg thrust using a rotor of ϕ = 10 inch

$A= \Pi * R^2 = 3.14 * 0.127 = 0.05067\ m^2$

$P_{IND} = T * \sqrt{T/2\rho A} = 10 * \sqrt{10/2*1.225*0.05067}$

$P_{IND} = 89.75\ W \approx 90\ W.$

Power = V * I

Taking standard 3S LiPo battery producing 11.5 V

I = PIND/V = 90/ 11.5 = 7.82 A

I(Amps) supplied to ESC = 30 A , taking losses into consideration sufficient power can be delivered to the motor for sustained flight.

Balancing- Moments on the CG of Drone

Thrust produced by 1400 KV motor = 940g

Taking 75% of thrust produced for flight opertaions, we have 75% T = 705g

Standard frame size for a 10 inch propeller = 500 mm [Wheelbase]

We have 25% T extra available at each motor for offset stabilization, ie 235g.

Servo-Stall Torque

Moment on the lower arm link servo = 250 * 500 * 10-3 = 12.5 kg-cm.

To support 500g at the end of lower arm we need to produce a moment of 12.5 kg-cm at support end of link.

Such a servo is available off shelf. [Tower Pro MG995 Metal gear Servo motor 180 Deg Rotation]

Weight = 55g

Operating voltages = 4.8 to 7.2 V

Stall Torque @ 6.6 V = 12 kg-cm

Chapter 8

SIMULATION

The proposed IOT based drone for pest control was evaluated by using the UAV simulator model that was developed by De Rango et al. The simulator models the movement of the UAV by using a local map. The map generates localized information such as the number of plants in a field and pest infestation. In addition the map estimates the movement of the parasites and the likelihood of pest infection. The periodical movement of the drone enables it to gather new information and updates its map. The drone reads from the local map the next part of the field to assess and is programmed not to replicate its operations in the same part of the field.

The performance of the proposed model was simulated using a number of input parameters namely pesticide tank capacity, minimum and maximum battery capacity, energy consumption, recharge time and minimum quantity of pesticide required to inactivate a pest. The outputs of the simulation results include energy consumption and killed (Fig. 42 and Fig. 43). The simulation results closely relates to the range obtained by De Rango et al. Fig.40. shows the amount of energy consumed for flooding for 1 hop. In comparison the energy consumption of the propose model is shown in Figure 42. The amount of energy consumed by the proposed model levels after 2.5 milliseconds and therefore results in significant energy savings in comparison to other drones tested by De Rango et al. The proposed model is lightweight and hence minimizes the amount of energy consumed in drone movements and spraying. Research indicates that a drone consumes minimal energy if it travels at a constant speed.

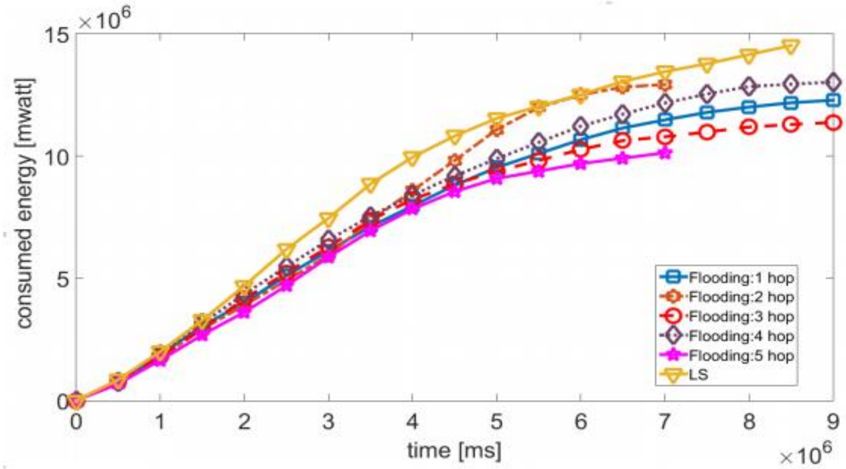


Fig. 40. Consumed energy vs topology update time for flooding.

The other parameter simulated is the number of pests killed by the drone during a spraying event. The simulation indicates that the proposed drone can kill about 400 to 1000 parasites within a 2-hour time period of operation (Fig. 43). Nonetheless, it is likely that an increase in the number of drones deployed to at least 12 drones will increase the number of killed parasites to more than 2500.

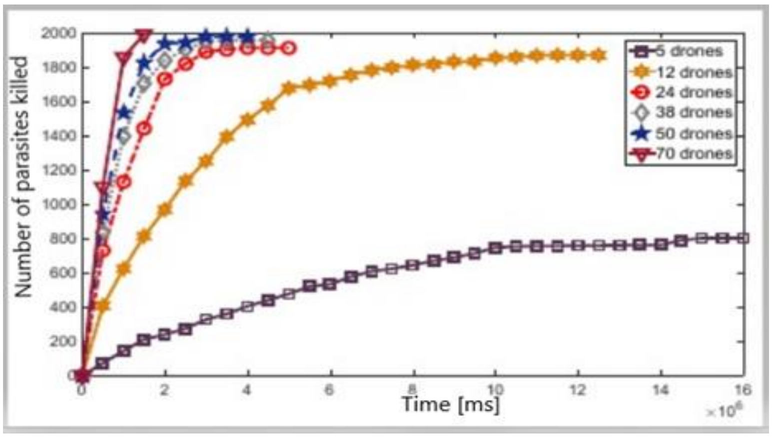


Fig. 41. Number of killed parasites against number of drones in operation.

Fig. 41. shows comparative number of parasites killed in a simulation by De Rango et al. The proposed IOT-based drone is optimized for real monitoring of parasite infection in the field hence in comparison to conventional drones it is likely identify pests and to cover a large tract of infected field within a short period of time. As a result, the drone has a higher efficiency and kills more parasites per unit time.

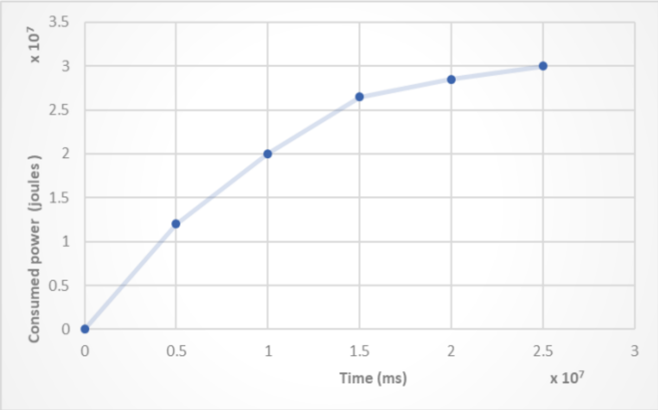


Fig. 42. Power consumption of proposed model.

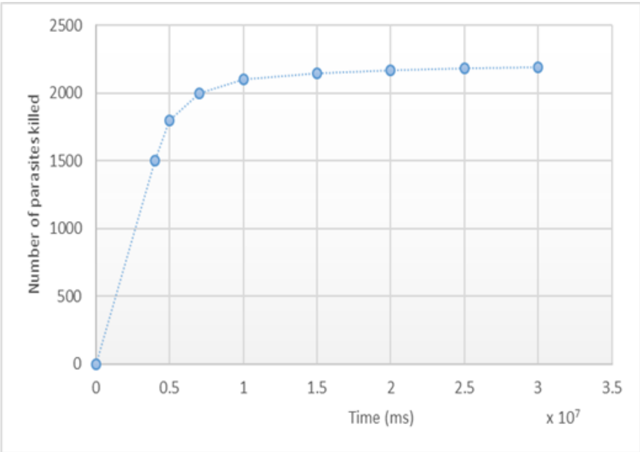


Fig. 43. Number of parasites killed by a single drone.

Moreover, the drone has a long operating time because it incorporates a 16,000mah battery which increases flight time. In addition, the number of recharge times is significantly reduced hence an increase in productivity.

Chapter 9

CONCLUSION

Thus, we can conclude that drones or UAVs will be of immense help in the field of agriculture with the increase in population as they are essential at the very beginning of a crop cycle. It will not only reduce time but also yield better cultivation based on analyzed data. Crop management will be more efficient due to systematic monitoring. With the upcoming technologies, the production rate will increase rapidly with lesser consumption of energy. Drones are not just used in the analysis of soil and fields but also in planting seeds and shooting plant nutrients in the soil. Crop monitoring obstacles faced previously can also be done away with the help of drones. The application of drones does not stop here when embedded with hyper spectral, thermal-spectral or multispectral sensors, drones can identify which parts of the land are dry and thereby assessing an irrigation plan becomes easier. Additionally, drones also find use in assessing the crop health by scanning them using near-infrared and visible light. Thus, drones serve as a perfect aerial platform for gathering the data needed in precision agriculture.

FUTURE SCOPE

On further improvements to the drone there are plans for installation of solar panels on the drone itself. By installing solar panels, the need for external charging is eliminated and the drone can charge during the day when it is operating on the field. Another future application may be the use of the Support Vector Machine (SVM) for classification of crops and plants according to yield. The SVM can work on a given database of crops and their respective physiological characteristics and time of yield. Using this, the SVM can predict appropriate yield times of the planted crops, or it could predict the time of ripening of fruits with sufficient accuracy.

CHAPTER 10

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