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# Design and Development of a Drone for Spraying Pesticides, Fertilizers and Disinfectants

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**ABSTRACT:** There are too many technologies involved in today's Agriculture, out of which spraying pesticides using drones is one of the emerging technologies. Manual pesticide spraying causes many harmful side effects to the personally involved in the spraying process. The Exposure effects can range from mild skin irritation to birth defects, tumor, genetic changes, blood and nerve disorders, endocrine disruption, coma or death. The WHO (World Health Organization) estimated as one million cases of ill affected, when spraying the pesticides on the crop field manually. This paved the way to design a drone mounted with spraying mechanism having pump, liquid storage capacity tank, nozzles to atomize in fine spray, an Quad-copter configuration frame, suitable landing frame, Brushless Direct Current (BLDC) motors with suitable propellers to produce required thrust and suitable Lithium- Polymer (Li-Po) battery of current capacity 22000 mAh and Voltage to meet necessary current and voltage requirements. A First-Person View (FPV) camera and transmitter can also be fixed in the drone for monitoring the spraying process and also for checking pest attacks on plants. This pesticide spraying drone reduces the time, number of labour and cost of pesticide application. This type of drone can also be used to spray disinfectant liquids over buildings, water bodies and in highly populated areas by changing the flow discharge of the pump.

**KEYWORDS:** Unmanned Aerial Vehicle(UAV), Agriculture, Payload, Sensors, Pump, Spray.

## I. INTRODUCTION

Abraham Karem is the man referred to as the founding father of drone technology. He is the pathfinder in inventive fixed and rotary-wing UAVs. Born in Baghdad, Iraq the family relocated to Israel, where he came of age. The first pilotless vehicles were developed in Britain and the USA during the First World War. It was tested in March 1917 while the American aerial torpedo known as the Kettering in October 1918. In 1935, the British produced number of radio-controlled aircraft to be used as a target for training purposes. Although originally built for military purposes, drones have seen rapid growth and advancements and made a break to consumer electronics. They use as original weapons, in the form of remotely guided aerial missile deployers. However, today, drones have found a wide range of applications for civilian use, especially in the form of small Quad-copters. From ancient history to till now the aircrafts were developed and updated their use and capabilities, as we are seeing in the Ukraine and Russian war how they are utilizing their aircraft powers. Today, drones are used for a wide range of functions. Drones including monitoring climate change, delivering goods, aiding in search and security operations, and in filming and photography. "A drone, in technological terms, is an unmanned aircraft. Essentially, a drone is a flying 1.1. robot that can be remotely controlled or fly autonomously through software – controlled flights plan in their Figure embedded systems, working in conjunction with on board sensors and GPS.



Fig.1 Image of Drone (1918)



until World War I that the first pilotless torpedo was invented by the Dayton-Wright Airplane Company. Essentially, a drone is a flying robot that can be remotely controlled by using a software control flight plains in its embedded system, that works in the combination of sensors and global positioning system (GPS). Drone was invented by ABRAHIM E KAREM, in ISRAEL by the reference of WRIGHT BROTHERS. Drones are more formally known as unmanned aerial vehicle (UAVs) or unmanned aircraft systems. Drones in today’s world have also been an important part of the film industry and news reporters are also using them to carry information from inaccessible locations. A typical unmanned aircraft is made of light composite materials to reduce weight and increase stability. This composite material strength allows military drones to cruise at extremely high altitudes. UAV drones are equipped with a different state of the art technology such as infrared cameras, GPS, laser (consumer, commercial and military UAV).



Fig. 2. Quad-copter Pesticides Drone

Drones are controlled by remote ground control systems (GSC) also referred to as a ground cockpit. Drones are now also used in a wide range of civilian roles ranging from Figure 1.2. Quad-copter Pesticides Drone search and rescue, surveillance, traffic monitoring, weather monitoring and fire fighting to personal drones and business drone-based photography, as well as videography, agriculture and even delivery services. As per a recent new update, Google and Amazon are developing their drones so that parcels can be delivered by air with ease. One more interesting concept is presented by Facebook as they are thinking to develop some giant drones that can carry the signal to remote locations for direct internet access. Drones in today’s world have also been an important part of the film industry and news reporters are also using them to carry information from inaccessible locations. The engineering materials used to build the drone are highly complex composites designed to absorb vibration, which decrease the sound produced. These materials are very lightweight. UAV drones come in a wide variety of sizes, with the largest being mostly used for military purposes such as the Predator drone. Here we are discussing about the development and design of agricultural drone sprayer of fertilizers, pesticides and disinfectants and how these will help for cropping and also for farmer health problem, crop monitoring.

Paper is organized as follows. Section II describes Requirements for design of robot. Section III discussed methodology. Section IV presents Applications shown.. Finally, Section V presents conclusion.

## II. REQUIREMENTS FOR DRONE



Fig. 3. Parts of the agricultural drone

The construction of a brushless motor may resemble that of a stepper motor. The stepper is like a brushless motor is usually used to produce continuous rotation, Stepper motors generally do not include a shaft sensor for internal feedback of the rotor position. They are frequently stopped with the rotor in a defined angular position.



Fig.4 BLDC motor

A Lithium polymer battery or lithium-ion polymer battery (Li-Po, LIP). The battery is rechargeable battery of lithium-ion technology using a polymer electrolyte instead of a liquid one. High conductivity semisolid gel polymers form this electrolyte. These batteries provide a higher specific energy than other lithium battery types and are being used in application where weight is a critical feature like cellular telephone handsets or radio controlled aircraft.



Fig.5 Li-Po Battery

A propeller is a type of fan that transmits power by converting rotational motion into thrust. A pressure difference is produced between the forward and rear surfaces of the airfoil-shaped blade, and a fluid is accelerated behind the blade and its dynamics are like those of aircraft wings can be modified with both of Bernoulli's principle and Newton's third law. A marine propeller of this type is sometimes colloquially known as a screw propeller.



Fig.6. Propellers

Here we are using aluminum to design our frame, building our frame with aluminum is better, because it would not break easily while the drone working or collided with any object. The carbon fiber is very tough and light weight. The combination of both makes the drone to fly effectively, consumes less power and it fly better. Carbon fiber impedes RF signals, so make sure that you keep this in mind while mounting important electronic components.



Fig.7. Quad-copter made with aluminum Frame



Designed by the father of the KK revolution, Rolf R Bakke, exclusively for HobbyKing, the KK2.0 is the evolution of the first generation KK flight control boards. The KK2.0 was engineered from the ground up to bring multi-rotor flight to everyone, not just the experts. The LCD screen and built in software makes install and setup easier than ever. A host of multi-rotor craft types are pre-installed. Simply select your craft type, check motor layout/propeller direction, calibrate your ESCs and radio and we are ready to go all of which is done with easy to follow on screen prompts.

The Hobby King KK2.0 Multi-Rotor control board also uses signals from your radio systems receiver (Rx) and passes these signals to the Atmega324PA IC via the ail, ele, thr and rud inputs. Once this information has been processed the IC will send varying signals to the ESCs which in turn adjust the rotational speed of each motor to induce controlled flight (up, down, backwards, forwards, left, right, yaw). The Atmega324PA IC unit then processes these signals according to the users selected firmware and passes control signals to the installed Electronic Speed Controllers (ESCs). These signals instruct the ESCs to make fine with specifications adjustments to the motors rotational speed which in turn stabilizes your multi-rotor craft.

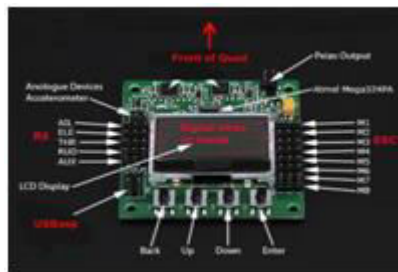


Fig.8: KK 2.0 flight controller Pin identification



Fig.9. KK 2.0 flight controller setup

The L3GD20H is a low- power three axis angular sensor. An angular Gyroscope is a device that produce a positive going analog output for counter clockwise rotation around the sensitive axis, Sensitive defined as the gain of the sensor and can be determined by applying a definite angular velocity to the Gyroscope. Gyroscope values depends on the temperature and time and includes sensing element and an IC interface able to provide the measured angular rate to the software

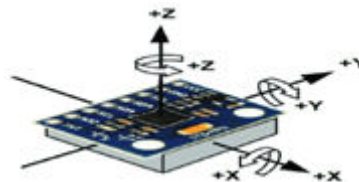


Fig.10. Gyroscope

An electronic speed controller or ESC is an electronic circuit that controls and regulates the speed of an electric motor. It may also provide reversing of the motor and dynamic braking. Electronic speed controllers are used in electrically powered radio controlled models, full size electronic vehicles also have systems to control the speed of their drive motors.

Different types of speed controls are required for brushed DC motors and brushless DC motors. A brushed motor can have its speed controlled by varying the voltage on its armature. A brushless motor requires a different



operating principle. The speed of the motor is varied by adjusting the timing of pulses of current delivered to the several windings of the motor. Brushless ESC systems basically create three phase AC power, as in available frequency drive, to run brushless motors. Brushless motors are popular with radio controlled airplane because of their efficiency, power, long and lightweight in comparison to traditional brushed motors. Brushless AC motor controllers are much complicated than brushed motor controllers.



Fig.11 Electronic Speed Controller (ESC)

The FLY SKY FS IA6B RF 2.4GHz 6CH PPM output with iBus port receiver works great with the FlySky FS-i6 Controller. This compact 6 channel receiver is great for any model using up to 6 channels and, with a range exceeding 500 meters, it can be considered to be the full range for all but the most demanding of application. The receiver has end-on connectors to enable a neat installation in tight spaces. This has FLY SKY FS IA6B RF 2.4GHz 6ch PPM output with iBus port receiver built in connectors which allows you to use any of the optional FlySky telemetry sensors. Dual antennas give the FS-IA6B excellent reception and interference rejection capability. With easy binding, compact dimensions, optional telemetry, and dual antennas.



Fig.12 FS-IA6B Receiver 6 Channel PPM Output with iBus Port 2.4GHz RC

It has a standard frequency of 2.4 GHz of antenna; it can be folded 90 degrees and can also be rotated for easy storage. It is completely made of plastic but when we consider the price is also affordable to purchase. The sticks are for a flight controlling as TRANSMITTER, the right stick is free and sprung in both directions and the left is also free on the left right axis, but lightly unsprung when it is in the vertical plane. Trim tabs are the traditional ratcheted type for all axis. The remaining controls are two rotary potentiometers labeled VR (B) and VR (A) which turn approximately 270 degrees and two small switches labeled as SW. B and SW. A. There is not more to say about the RECEIVER, it is fairly small and does not appear to have battery eliminator button (BCE) so, probably fry if connected to an older Tamiya ESC, and there is no bind button. Here half of the antenna is hidden by heat shrink tubing.



Fig.13 Fly-Sky FS-CT6B

T6 configuration, power on your Transmitter, and select the COM port you assigned to the USB cable. Now you should see the channel bars moving as you manipulate the Transmitter sticks. If the channel bars do not respond to sticking the movement and then double check the steps above. If everything is correct.



Fig.14 Bind and setup for Radio controller

COMPOUND NOZZLE. Single-fluid spray nozzle utilizes the kinetic energy of the liquid to break the outlet drops into spray and the fluid pressure increases then the flow through the nozzle and drop size also increases, the stationary core has a rotary fluid motion which causes the swirling of the fluid in the swirl chamber, the film is discharged from the perimeter of the outlet producing a characteristic hollow cone spray pattern and the surrounded gas is drawn inside the swirl chamber to form air core within the swirling liquid.



Fig.15. Agricultural drone spray system nozzles, Water pump Buck module, Pump governor, Adapter, Water pipes

Constructing of a Quad-copter Drone the hardware parts must be considered such as the estimation of payload, weight of the motor, propeller, electronic speed controller (ESC), pump, radio transmitter and receiver and the frame of the drone to be calculated. The battery is to select the knowing the battery current and voltage requirements suitable to the components, the thrust requirement must be calculated and the drone frame is estimated the arm number, arm length, and payload application.

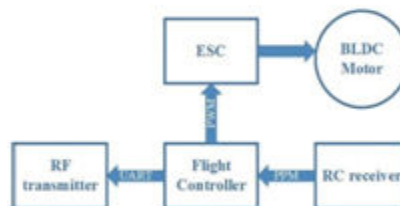


Fig.17 Block diagram of FC and Transmitter connectivity

### III.METHODOLOGY

Exemplar based inpainting technique is used for inpainting of text regions, which takes structure synthesis and texture synthesis together. Multi-Rotor works on the relative nature of force, which means when the rotor pushes the air, the air also pushes the rotor back. This is the basic principle that the Multi-Rotor can go up and down and here for the project this principle is better suitable for Quad-copter drone. Furthermore, the faster the rotor rotates, the greater the lift, and vice versa. To achieve the controllable flight, the drone mainly needs to complete the attitude control, shooting, information storage and transmission, and environmental awareness like the anti-collision.

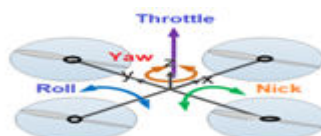


Fig.18: Angle & Axis representation of Quad Copter

A starting point of the automatic control principle is the closed-loop feedback control, after the input adjustment is applied to the drone, the change of the control amount is measured and feedback is adjusted to input until the control amount reaches the locating point.

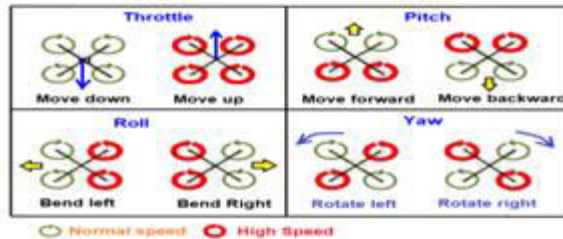


Fig.19: Controls of the Quad-copter

In a Quad-copter, the two propellers turn one way such as clockwise direction and the other two turn the other direction such as counter clockwise and this empowers the machine to float in a stable manner, Right of the engines which we are utilizing for a conspicuous reason to run the propellers. Motors are appraised by kilo voltages, the speed engine turns at a consistent voltage. Now, Electronic Speed Controllers (ESCs) were gives the instructions to the motors to run quickly at any given time.

The vertical force acting on the drone is called lift. This force is due to pressure differences across the drone (in the vertical direction). Hence, the speed, size, and shape of the propeller blade decide the amount of lift force. Lift is essential to lift the body against the gravity. To create this force, all four propellers run at high speed to lift the drone.

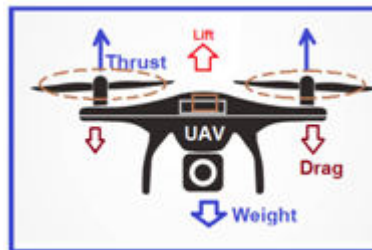


Fig.20 Drone Balancing using Propellers w.r.t Weight

The force acting on the drone in the direction of motion is called thrust. However, for drone dynamics, it is normal to the rotor plane. During hovering, the thrust is purely vertical. If thrust is inclined then the drone will tilt forward or backward. This force is essential to move the drone in the desired direction at equal speed to get desired motion, two propellers have been given high speed.

Distance-measuring equipment's like ultrasonic echoing and lasers drones can adjust altitude with a change in topography and geography. Their ability to scan and modulate its distance from the ground enables them to spray the correct amount of the desired liquid evenly in real time. This results in increased efficiency with a reduction in amount of chemicals penetrating into groundwater. In fact experts estimates that spraying using drones will be proven 5 times faster than the traditional methods.

#### IV. APPLICATIONS

##### Soil and field analysis:

Drones can be used for soil and field analysis. They can be used to produce accurate 3-D maps that can be used for early soil analysis on soil property, moisture content, and soil erosion. This is very important in planning seed planting patterns. Even after planting, drone-driven soil analysis provides data for irrigation and nitrogen-level management in the soil.





**Planting:**

Though not quite prevalent just yet, some manufactures have come up with systems able to shoot pods with seeds and plant nutrients into the already prepared soil. These drone-planting systems will decrease planting costs by 85%.

**Crop monitoring:**

One of the largest obstacles in farming is inefficient crop monitoring of vast fields. Monitoring challenges are made worse by the rise of unpredictable weather patterns which leads to increased risk and maintenance cost. Previously, satellite imagery offered the most advanced form of monitoring. But there were drawbacks. Today drones equipped with surveillance technology, creating time series animations that can show the precise development of a crop and reveal production inefficiencies, enabling better crop management.

**Irrigation:**

Drones with hyper spectral, multispectral, or thermal sensors can identify which parts of a field are dry so water resources can be allocated much more economically i.e. more water for the dry areas and less for the wetter once. Additionally, once the crop is growing, drones allow the calculation of the vegetation index, which describes the relative density and health of the crop, and show the heat signature, the amount of energy or heat the crop emits. more precisely.

**Mid-field weed identification:**

Using NDVI sensor data and post flight image data we can create weed maps that will help the farmers in easily differentiate the high weed intensity areas from healthy crop areas which are growing alongside them.

**V. CONCLUSION**

In this paper we have described a design of a drone mounted spraying mechanism for Agricultural purpose and for spraying disinfectants. This method of spraying pesticides on Agricultural fields reduces the number of labours, time, cost and the risk involved to the personnel involved in spraying the liquids. This drone can also be used in spraying disinfectant liquids over buildings, water bodies and highly populated areas

**Future Scope**

India is categorized by small-scale farms. Furthermore 80% of total agriculture land in the country is divided into pieces of less than 5 acres. The majority of the crops are depends on rain, with just around 45% of the land irrigated. It determines that around 55% of total population of India depends on farming which is dependent on rain. Due to poor availability of funds, agriculture inputs like fertilizers, irrigation, seeds and pesticides, no farm insurance, terrible support price structure for the mass- produce, most of the farming is un-remunerative and more than half of the farmers in India are in debt. This is the vital basis behind the more farmer suicides. Again in some part of the country, due to intensive production and mechanization in the latter half of the last century it was not possible to take care of the within field spatial variability. So these developed area required advanced PF technology to be applied. Wealth and security of the nation come from its land and hence its need to be sustainable, innovative and high- productivity agriculture which will be profitable and provide both food and energy security for the country. Hence, it is believed that some advance farming technologies will help to promote the next green revolution to Indian agriculture. Agricultural drones are used for precision agriculture, which is a modern method of farming that uses big data, aerial imagery and other means to optimize efficiency. By generating detailed insights, farmers can make data-based decisions that will optimize yield and boost revenue while minimizing expenses and the chances of crop failure.

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