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Fire detection and pesticide spraying using drone

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Abstract: In India, 73% of rural people depends on the agricultures and forests. Due to forest fire issues and diseases caused by insects and pests in fields, they have faced heavy loss and it also reduces the crops productivity. In order to enhance the crop quality chemical fertilizers and pesticides are used to kill the pests and insects. According to the research of World Health Organization (WHO) about a million of people are ill affected by manually spraying the pesticides and fertilizers to the crop, to reduce these threats and huge losses to ecosystems. To overcome this problem the Unmanned Aerial Vehicle (UAV) aircrafts can be used to detect the fire at the early stage and to spray the chemical pesticides and fertilizers in order to avoid the health issues for people who are involved in spraying manually. Also, we have many developments in agriculture for increasing the production of crop using drone. The agriculture UAV drone used to expand the all areas of field which the drone will be able to cover it and the drones are highly capable, and also includes fertilizer and pesticides spraying, seed sowing, mapping etc. The market for agriculture UAV drones is expected to grow continuously by relating the technologies.

Keywords: UAV, Flame Detector Sensor, Artificial Intelligence, Smart Farming, IoT.

I. INTRODUCTION

We know that majority of the crops which yield good quality of food are dependent on the rain with around 55% of the land which is not irrigated, that is around 45% of the land being irrigated. However, the total population in our country is dependent on the former who are dependent on rain for a good yield of the cops for their forming [1, 2]. Due to various changes in climatic conditions, terrible labour shortage and more labour cost, crops tend to loss due to pest, poor availability of agricultural funds and inputs, input wastage, poor support price structures all of these are the problems which causes the limit to access for proper quality of food for the living [2]. Agricultural drone might be used for spraying pesticides, and can be used for seeding and it helps prevent the crops from birds. Agricultural drone can also determine the temperature of the surrounding environment. To solve all the above-mentioned problems, we here propose a project to design and implement a multipurpose drone [3]. The various factors are been driven by market such as growth in agriculture sector, farm mechanism and government initiatives. Also, the increase on productivity in agriculture sector resulted in an increased use of crop sprayers. Now, the farmers are moving from traditional technologies to new way of farming [4, 5]. The modernization in agriculture increases the productivity also the capital income. By adopting new modern technology, farmers intend to use mechanization equipment. A drone that is compact and thus less costly and more effective [5]. This multipurpose drone can also be used in agriculture for spraying pesticides and fertilizers as well as for sanitization of streets, corridors and open areas. Implementing and making it multipurpose makes it even more worth to buy as it fulfils more than one purpose. Incorporating the latest information and development, the majority of the problem in forests is the forest fire [6]. They cause the disturbance to the entire flora and fauna causing imbalance in the ecology and in bio-diversity and also in region environment. The main causes and reasons for forest fires occurs naturally, they are lightning, low humidity and high atmospheric temperatures. Fire can also be caused by human interaction such as cigarette and bide, naked flame or any contact with electric spark. There are many important precautions to avoid forest fires. But when it comes to natural disaster, no precautions can be taken. The only solution is to detect the fire sooner and inform the nearby fire station [7, 8]. The government has to initiate an organization in the community so as everyone can hire the result of forest fire in the community and to the world and government should establish policy that will guide and make people fear doing any such kind of act. These are the adverse effects of forest fires. A drone that we are implementing will overcome the problems faced by the forest fires by deciding the amount and type of resources to carry to the area of a forest fire. The drone we proposed are equipped with sensors which are thermal that use infrared radiation which is about to spread [9]. This drone will detect the fire in the surrounding environment through the flame sensors and it immediately informs the information to the nearby fire stations across the area, so that they reach earlier and take certain actions. Farmers in India spray pesticides on their own which takes a lot of time and they may get affected to certain allergies and other such health issues. The drone proposed in our project will spray

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pesticide and also it can multitask such as spraying seeds and detecting fire with the help of flame sensors. It helps to reduce time in spraying pesticides. There are mainly two types of drones, they are fixed wing drone and rotatory wing drone [10]. The proposed drone with fixed wing, its function is to patrol the area monitored. The altitude in which the drone will fly is medium that is 350 to 5500m. The function of rotatory wing is to inspect the area affected and suspect the fire that have occurred. The important feature includes the early detection of fire event. The aim of the project is to protect the flora and fauna of the country.

II. METHODOLOGY

A. Flow diagrams

Figure 1 flow diagram will be followed for the implementation spraying pesticides using drone. Pump will be used for intake fluid and produce it to the tank, and from tank the fluid will pass through valve to nozzle spray. By this the fluid is sprayed all through the field and the drone can be controlled and navigated by the hand controller [1-8].

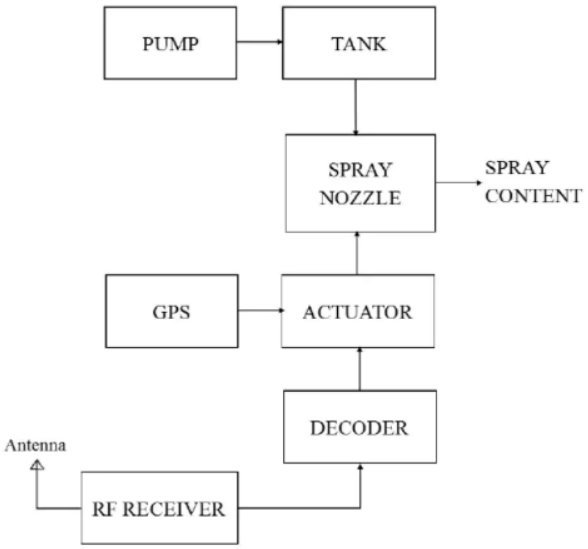

Figure 1: Flow diagram for the implementation spraying pesticides

Figure 2 as shown the flow implementation for fire detection. The system has to implement by three stages for detecting the fire. The first step represents the fixed-wing roll of a DRONE. For a wide-angle view the drone should fly at an altitude from 360m to 5400 m. If fire was detected, the drone starts to fly at low altitude at the affected area. At the third stage, drone has to confirm whether there is fire or not. If the fire is detected at suspected area, the vehicle has to report the ground fire-fighting services and it has to continue the assisting of ground level service.

Drones are equipped with IR cameras and flame sensors. The detection for fire can be analysed. Images captured by IR cameras will be produced Normalized Difference Vegetation Index (NDVI) which used to generate the NDVI maps of the terrain. NDVI graphical map indicates the fire damage assessments [1-5]. The signal sent from the drone is transmitted to the ground station through transmitter and received through the receiver and alarm system goes on.

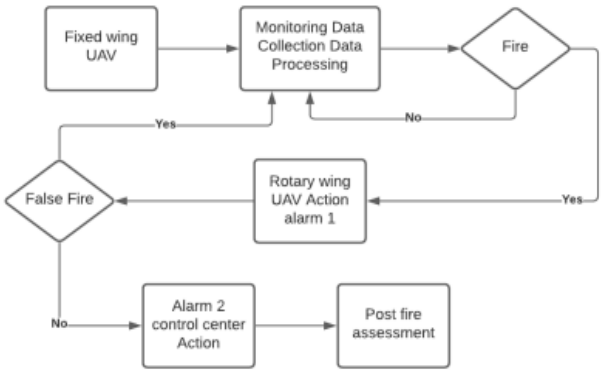

Figure 2: Flowchart for fire detection

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Flame detector sensor which is used to detect the fire and transmit or respond to the specified device. When the sensor detects flame, it sounds an alarm. A flame detector is more accurate and faster than a smoke detector because it was built to detect the flame.

An unmanned aerial vehicle, where it is also called as drone, it is an aircraft without presence of human pilot, passengers, crew etc. on the vehicle. UAV is one of the parts of an Unmanned Aircraft System (UAS) which also have a ground controller to control the drone and a system to communicate with the drone. The flight of UAVs is controlled by a human operator remotely, where they are called as Remotely Piloted Aircraft (RPA). Drones are fully autonomous aircraft that have no human intervention.

B. Steps and procedure to build drone

Step 1: Assembling drone motors

In the first step, we have to fix the motors and propellers on the frame with screw.

Step 2: Fix electronic speed controllers (ESCS)

After mounting the motors, fix ESCs to the drone's frame bottom so that they will give more free space for other components that will be added at the top.

Step 3: Mounting the landing gear

To avoid the damage and accidents of drone when it lands on the ground a landing gear is attached to the drone which helps to absorb the shock. The flexibility and the strength of the material should be high. For example, plastic absorbs the shock and it doesn't break.

Step 4: Adding flight controller

A flight controller is necessary for flying a drone. This allows the drone to be stable and sense all the shifts and changes made by the wind. To control the vibrations caused by the drone, a piece of sponge is attached under the drone.

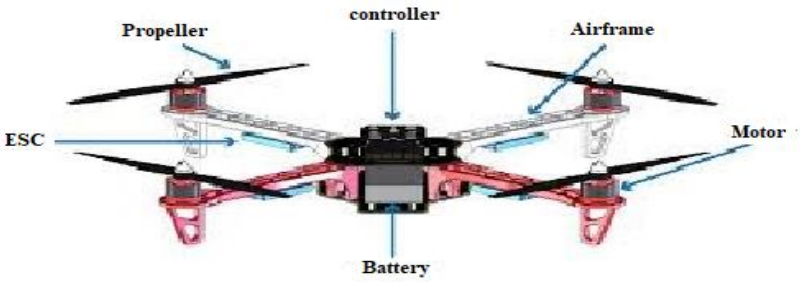

Figure 3: Body of Drone [10]

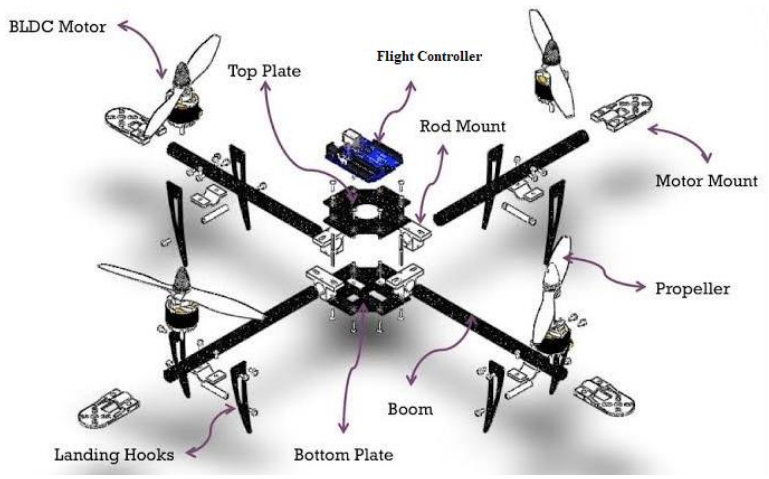

Figure 4: Parts of quad copter drone [15]

Figure 3 and figure 4 shows the body and parts of a quad-copter which has been implemented in the work. Initially, we should know the quad copter dynamics where they are defined by six degrees of freedom are defined by translational motions and rotational motions where it is generated from force and four motors which is used to produce moments.

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Where (x, y, z) are the reference frame which is used to describe the translational displacements. It also shows the inertial reference from which motor starts to rotate in the vehicle. Where each motor in structural frame of drone is placed at a distance "l" from the center, and also motor rotate at a speed of "wn" and also generate thrust force "fn" were thrust generated is perpendicular to the direction of plane of rotation. When the net force act at the center of the vehicle "F" and also the drone has net weight of mg, while it is hovering at the fixed point which is shown at figure 1 [14].

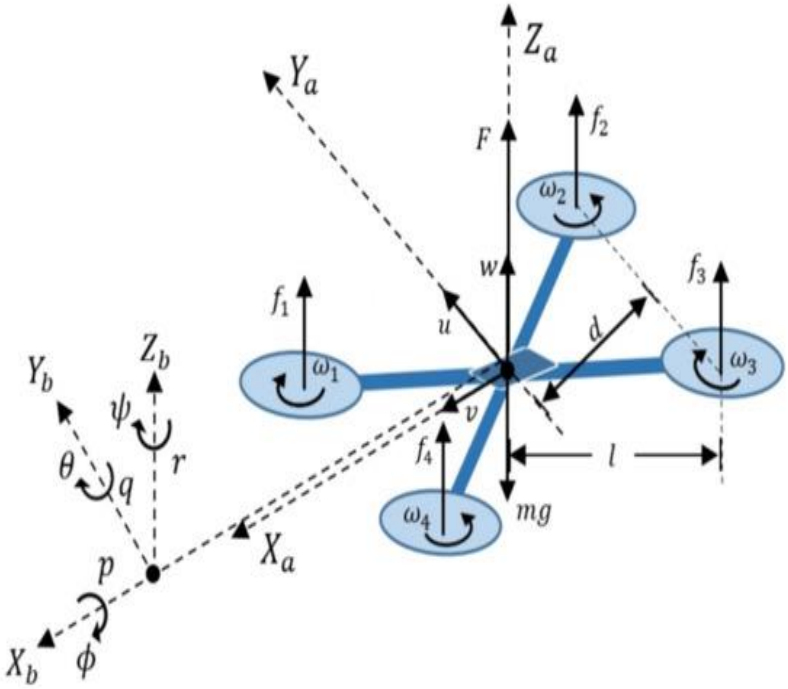

Figure 5: Axis [16]

Figure 5 explain the direction by the induction to the angular moment on references frame (x, y ,z) .The torque generated by the application give raise to rotational motions in the Drone which are yaw, pitch, roll. They are illustrated by Euler's angle. [17]

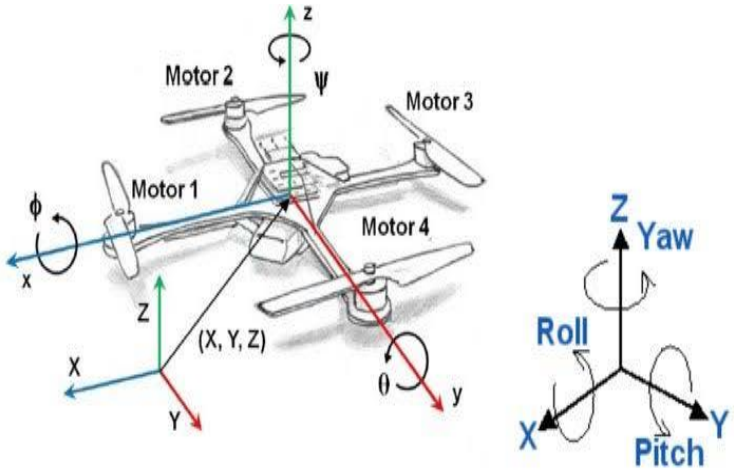

Figure 6: Pitch, roll and yaw axis [15]

The Drone structural design has two major functions, to resist the torques and forces present in the drone dynamic performance and also contain the required electronic components for the drone operation. Propeller protectors are made of PLA material. They have a height 60 mm, diameter of 170 mm and thickness of 3 mm. CAD model of quad copter structure. Arms are responsible for support and holding the motors as shown in the figure 6. They are made of carbon fiber with length of 350 mm and thickness of 4 mm. Center plate is a point where it joins the four arms of drone. Its elliptical segment has a geometry and also have thickness of 6 mm. where it is made of PLA material. The quad copter electronic system shown in figure 7, where they are connected as the diagram shown above. Third line represent Vdd, second line represent the communication signal, and first lines represents GND (Ground) where second line and first line

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are used for transmission of electric current through flight controller. One of the main points considered in this Quad copter electronic design is that the component is chosen based on the feasibility to build this drone. The part of electronic drone components is chosen based on devices which can be implemented in qav350 quad copter drone model, where it is inexpensive to build.

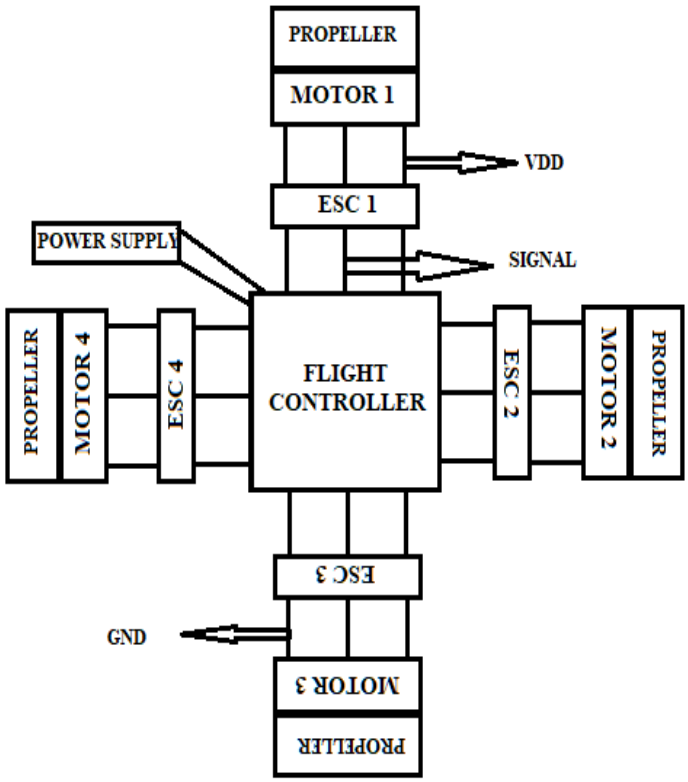

Figure 7: Quad copter Electronic Design [13]

C. Simulation using PID

We start with a plant. This is what we call the system that we want to control, or the system whose behaviour we want to affect. The input into the plant is the actuated signal and the output is the controlled variable. Different industries refer to these signals by various names, so you might hear them called something else like plant input and plant output. But regardless of the names, the basic idea of a control system is to figure out how to generate the appropriate actuated signal, the input, so that our system will produce the desired controlled variable, the output.

Figure 8: Transfer function using PID controller

PID Controller: The figure 8 shows the structure controller of PID in the transfer function which is been used in implementing the Drone. In this y(t) represents the present state of the system that's from signal from the flight controller. Where u(t) represents the value by sending the value through the PID controller and transfer function equation whereas Kp, Ki, Kd are the gains of the PID controller where it is proportional, integrated and derived [17].

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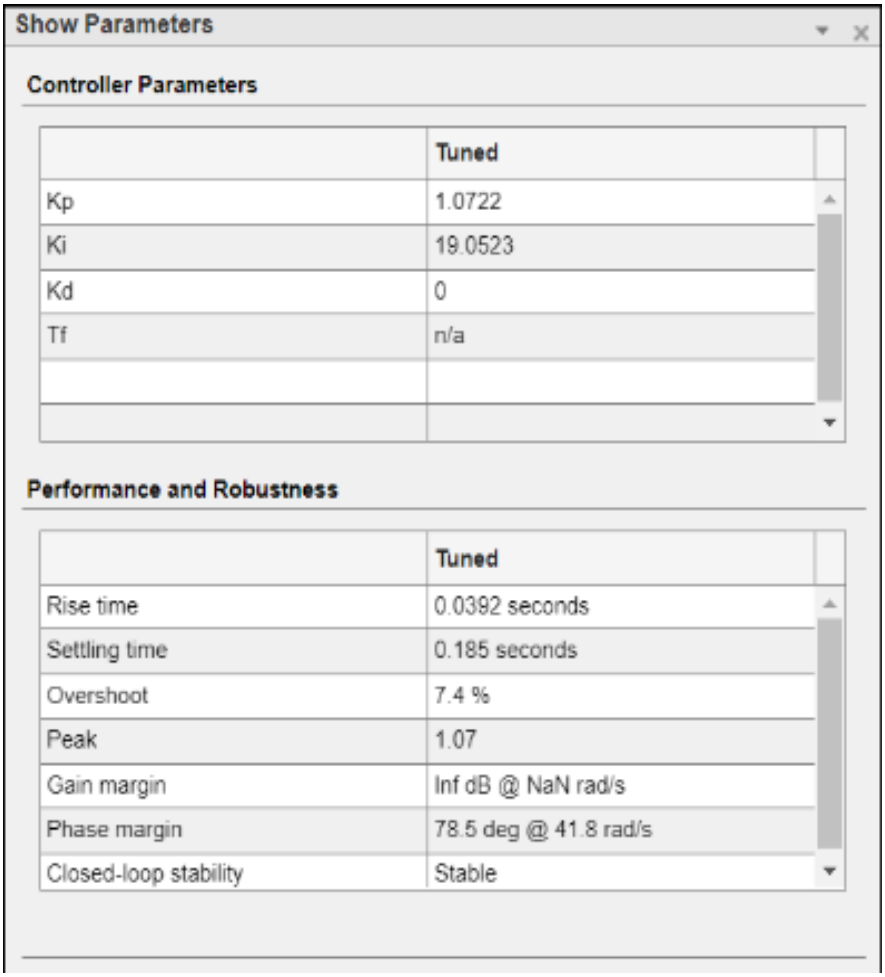

Figure 9: Parameter and tuning the controller

Form the figure 9 its show the parameter and tuning the PID controller. Were the overshoot being turned at 7.4% so the peak will be at 1.07 amplitude. And the values for Kp, Ki, Kd is mentioned the figure. Figure 10 shows the waveform of the tuning the PID controller.

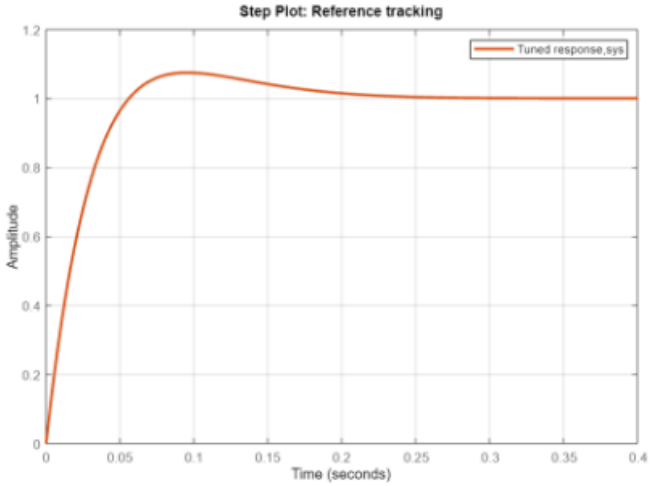

Figure 10: Tuning of PID controller

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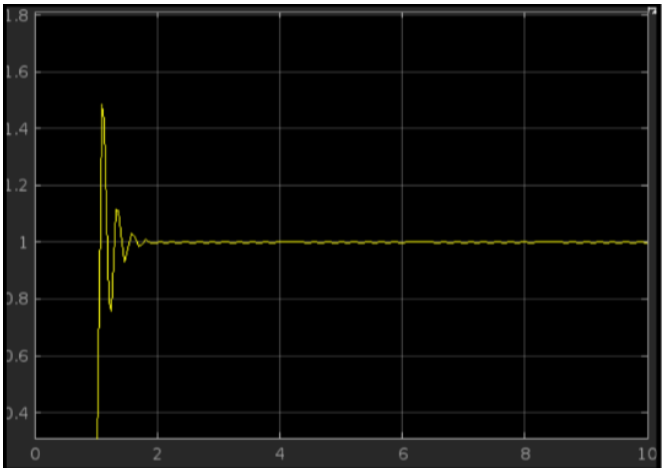

Figure 11: PID waveform

Figure 11 shows the waveform of PID controller. The value calculated using PID values and the values are tuned for simulating the waveform.

III. CONCLUSION

The Unmanned Ariel Vehicle aircraft is used to detect the fire at the early stage in the forests so that major losses can be avoided and to spray the pesticides and fertilizers on the agriculture fields in order to avoid the health issues caused by the chemicals to the people who are involved in spraying manually. The designed drone reduces the manual work and is time efficient. This will also reduce the labor cost.

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