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Quadcopter UAV Based Fertilizer and Pesticide Spraying System

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ABSTRACT

Indian agriculture needed production and protection materials to achieve high productivity. Agriculture fertilizer and chemical frequently needed to kill insects and growth of crops. The WHO (World Health Organization) estimates there are more than 1 million pesticide cases in every year. In that more than one lakh deaths in each year, especially in developing countries due to the pesticides sprayed by human being. The pesticide affects the nervous system of humans and also leads to disorders in body. A remote controlled UAV (Unmanned Aerial Vehicle) is used to spray the Pesticide as well as fertilizer to avoid the humans from pesticide poison. The UAV is operated by manual flight plans and the Sprayer is manually triggered by RF controlled Nozzle. The vertical take-off and landing quadcopter is used to spray the low volume pesticide in a small area. This project describes the development of quadcopter UAV and the sprayer module. And also discusses the integration of sprayer module to quadcopter system. This model is used to spray the pesticide content to the areas that can't easily accessible by humans. The Universal Sprayer system is used to spray the liquid as well as solid contents which are done by the universal nozzle.Multispectral camera is used to capture the remote sensing images which are used to identify the green fields as well as the edges of crop area. Total payload liftoff weight of quadcopter is 8 kg. Remote sensing images are analyzed by QGIS software.

Keywords: Unmanned Aerial Vehicle (UAV), Radio frequency (RF), Sprayer module, Remote sensing, GPS, Micro strip patch antenna, Normalized Differential Vegetation Index, Multispectral Camera.

INDRODUCTION

The quadcopter is cost effective alternate to high cost standard rotorcrafts. UAVs are rapidly upcoming method for cultivation, production and protection processes. The quadcopter was chosen for this project because of high stability and more lifting power. The control of quadcopter is easier than the helicopter model of vehicles. Some applications of quadcopter are Search and Rescue, Police, Code Enforcement/Inspections, Emergency Management, Fire, Surveillance, Border Security, Defense, etc.

The WHO (World Health Organization) estimates there are more than 1 million pesticide cases in every year. In that more than one lakh deaths in each year, especially in developing countries due to the pesticides sprayed by human being and handling of pesticides. 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. More pesticides are very dangerous carcinogens. Other pesticides may be

affects the hormone and endocrine system of the body. Even though very low levels of exposure during spraying may have leads to health effects. Pesticide exposure can cause a wide range of neurological health effects in body such as memory loss, loss of coordination, reduced speed of response to stimuli, reduced visual ability, altered or uncontrollable mood and general behavior, and reduced motor skills.

SOLUTION

UAV inbuilt pesticide sprayer is basically Sprayer integrated into a quad copter to spray pesticides and fertilizers in open crop fields. The main objective of this project is to reduce the ill-effects to humans. The quadcopter is used to spray the contents under any climatic conditions. The UAV inbuilt sprayer contains a universal sprayer which is used to spray the both Fertilizer and Pesticide on a same sprayer. The Universal nozzle is used to regulate the Liquid content as well as solid contents. The pressure pump is used on a Pesticide spraying and not on Fertilizer Spraying. Multispectral camera is used to capture the remote sensing images which are used to identify the green fields as well as the edges of crop area. GPS navigation is used here for auto guidance system for UAV.

REMOTE SENSE IMAGING

The remote sensing in agriculture is easy on now a day, because of new introduced technologies. Quadcopter and other drones are the best choice of mapping the remote sensing data. These are the low cost drones used in precision agricultural usages. Piloted aircrafts are more expensive method to map the remote sensing. Satellite data also costly method in agricultural remote sensing and also the real time remote sensing data is not possible with satellite. So, the Unmanned Aerial Vehicles are the best choice to map the remote sensing images. The information collected from these UAVs is good resolutions measured with inches per pixel. This remote sensing data is used to map the growth of crops, moisture level and more.

Multispectral camera

Multispectral camera used to capture the remote sensing images. This multispectral camera is attached with small unmanned aerial vehicles and manned aircrafts also. RedEdge multispectral camera provides an accurate multi-band data for agricultural remote sensing applications. This camera can take the images on following five band are Blue, Green, Red, Red Edge, Near-Infrared. Captured images are stored in single SD card or in cloud storage and same way the captured image is transmitted to ground station via Wi-Fi. The multispectral camera is used to capture the five distinct bands (Table 1) are Blue (440 – 510 nm), Green (520 – 590) nm, Red (630 – 685 nm), Red Edge (690 – 730 nm), Near-Infrared (760 – 850 nm).

After landing of the UAV, these images are taken into analyzing. The data from the multispectral camera is analyzed by the remote sensing or GIS software. Then the image is converted to Vegetation Index map. This data is used for farm management. This multispectral camera is coupled with any platform. Inbuilt GPS module maintains the GPS locations and time-stamping of captured images. So, we can easily identify the location of the green field. Then identification of the area going to spray will be easy. The GPS coordinates of the spray locations is stored in UAV for auto navigation. So, manual control is not needed to control the unmanned aerial vehicle.

Normalized difference vegetation index

Normalized Difference Vegetation Index (NDVI) is a geographical indicator which is used to analyze the remote sensing images.NDVI calculation gives a

value -1 to +1; no green leaves give a value close to 0. A zero (0) means no vegetation and close to +1 (0.8 to 0.9) indicates the highest possible density of green leaves.

Design of Micro-Strip Patch Antenna

Rectangular Micro-strip Patch Antenna (Figure 2) Incorporated with Innovative Meta-material Structure for Dual band operation and Amelioration in Patch Antenna Parameters with Negative μ and ε are designed and tested in RF Transmitter.

QUADCOPTER WORKING PRINCIPLE

The quadcopter is simple design with four rotor propellers with controller (Figure 3). The flight controller is the main part of this vehicle. This ardupilot controls all the operation commanded by us. The four rotors to create differential thrust and the quadcopter hover and move accordance with the speed of those rotors. There are two types of configuration in quadcopter construction. First one is Plus (+) configuration and another one is Cross (X) configuration. In this project we used X (Cross) configuration. Both the models are same, but the control of these models slightly different. The cross configuration is easier than plus configuration model. Total mass to lift is 4kg means, the total thrust produced by rotors should be 8 kg. GPS guidance system is used here to navigate the UAV. Pre-loaded trajectory gives the real time coordinates to ardupilot controller. Based on this GPS coordinates, the microcontroller navigates the UAV (Figure 1).

SPRAYER MODULE

Sprayer module (Figure 4) has two sections, they are 1) Transmitter section (Remote controller), 2) Sprayer with controller.Transmitter section used to control the actuator of sprayer module. The nozzle of sprayer module will be activated by remote control. Wherever need to activate the sprayer, just comment by remote RF transmitter. Sprayer module contains two sections, spraying module and controller. Spraying module contains the spraying content i.e., pesticide or fertilizer and the controller section used to activate the nozzle of sprayer. The command is received from remote controller which is activated manually. Tank contains the chemical content which is going to spray on crops that may be a pesticide or fertilizer. The Nozzle of the sprayer module will be activated by GPS device. This GPS module having the preloaded GPS coordinated,

Liquid Pump Motor with Tank

The spraying pump overflow rate is max, 1L/minutes. The maximum spraying height is 4 meters. Flying speed is max. of 5m/s. It covers 2m range of green fields with compatible land edge.

Coverage Rate

1) Minimum speed=2m/s

Coverage of sprayer=2m

Coverage

rate=2*2=4 sqm/s=0.000988422acre/s

CR per hour=CR*3600s

=0.000988422*3600=3.5 acre/hr

2) Maximum speed=4m/s

Coverage of sprayer=2m

Coverage

rate=4*2=8 sqm/s=0.001976843acre/s

CR per hour=CR*3600s

=0.001976843*3600=7 acre/hr

CONCLUSION& DISCUSSIONS

This method can be used in all situations, especially in the places where labours are hard to find. It has many advantages that include hastening the spraying process of pesticide thereby reducing the causalities due to pesticide exposures and hence prevents the encounters with the poisonous snakes like viper and cobra which are regularly found

in our agricultural fields. Environmental pollution can be reduced when it sprayed from lower altitude. This research has shown that a spray system was developed successfully, which is suitable for an UAV application platform. The pest management and vector control can be achieved by the integration of the spray system with the UAV results in an autonomous spray system. It has a great potential to enhance pest management for small as well as the large crop field to entail highly accurate site-specification application. It is also a good method for the vector control in the areas where there is lack of easily accessible by persons or equipment.

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Table 1. Specifications of the multispectral camera

Specification	Value
Spectral Bands	Blue, Green, Red, Red Edge, Near-Infrared
Ground Sample Distance	8.0 cm/pixel-per band at 120 m
Capture Speed	1 capture per second
Interface	Serial, Ethernet, Wi-Fi
Field of View	47.2 º HFOV
Power source	5.0 Vdc, 4 Watts
Weight	150 grams
Dimensions	12.1 x 6.6 x 4.6 cm

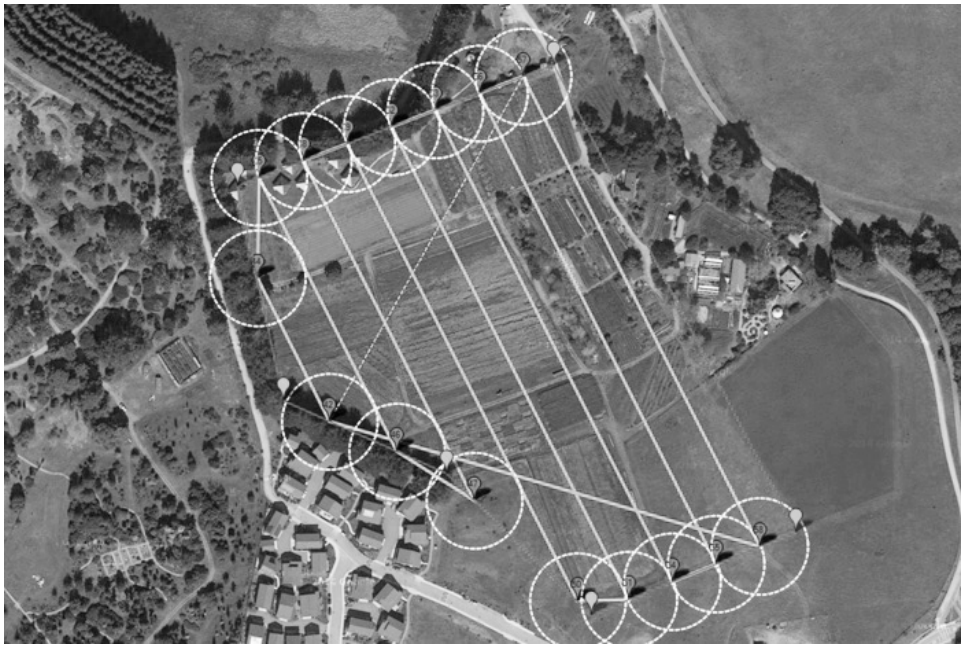

*Figure 1.*Edge detection of green field using multispectral camera and setting the trajectory of quadcopter.

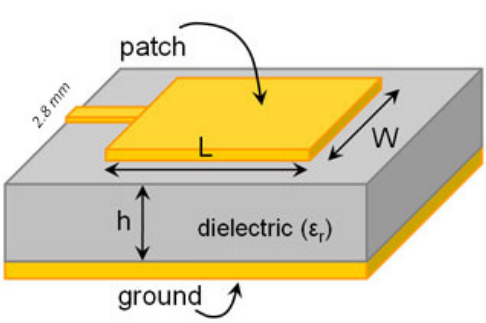

Figure 2. Design of Rectangular Micro-Strip Patch Antenna at 2.2 GHz

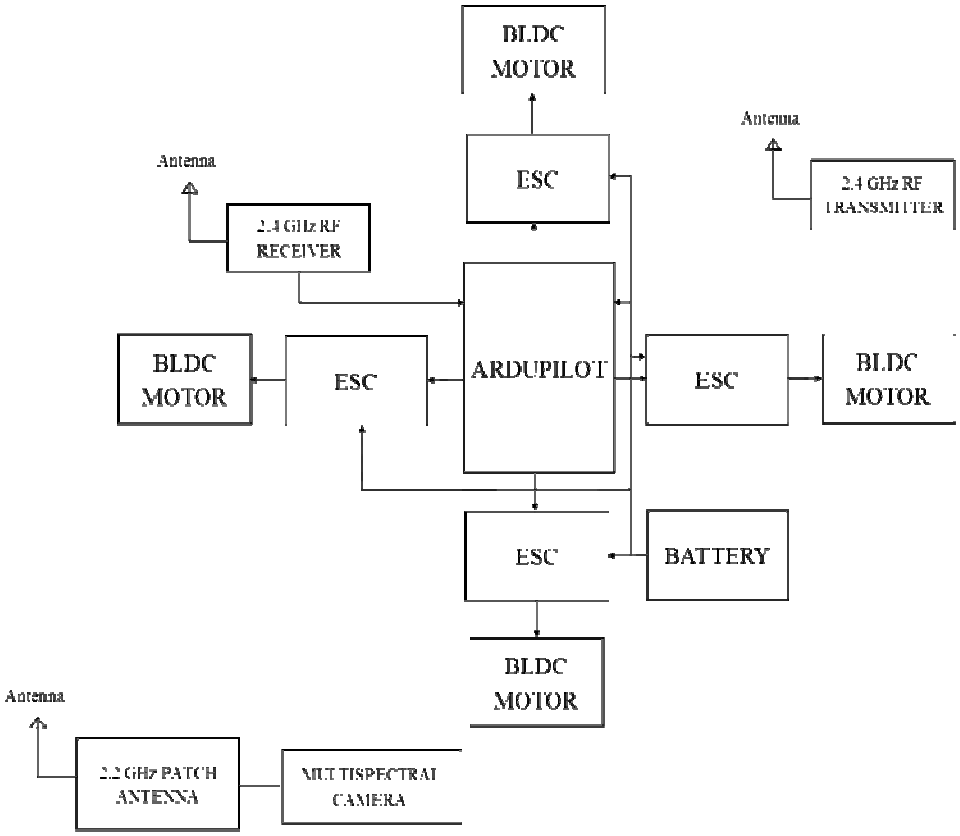

Figure 3. Block diagram of quadcopter. This figure shows the blocks incorporated in the design of quadcopter.

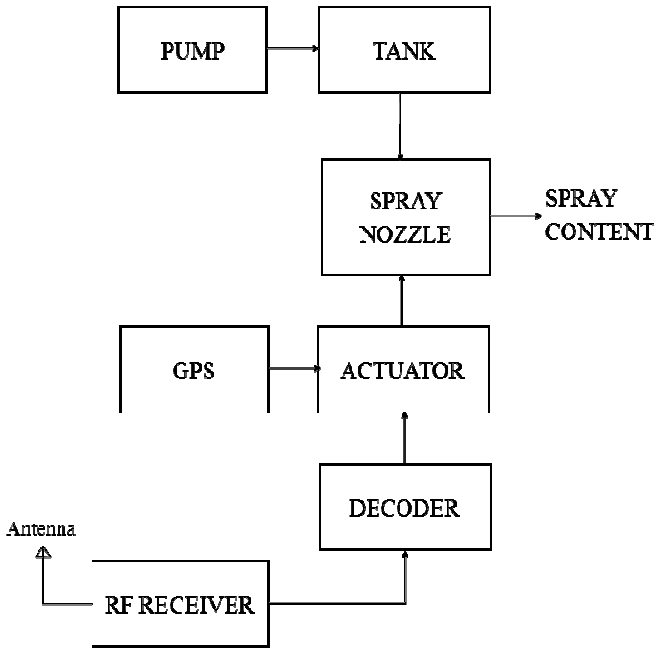

Figure 4. Block diagram of Sprayer Module. This figure shows the blocks incorporated in the design of sprayer module. The sprayer module is integrated into the quadcopter.