Automatic Spraying Of Fertilizers/Pesticides Using Drone

R. NIVAS[1], T. NAVEEN[2], T. CHIRANJEEVI SAI VENKAT[3], T. KARTHIKEYA KRISHNA RUDRA[4]
[1, 2, 3, 4] *Student, Vasireddy Venkatadri Institute of Technology, A.P, India*

Abstract- Use of fertilizers/pesticides in agricultural fields is necessary for better crop yields. The main disadvantage of manual spraying is that it can cause few health issues like respiratory ailments, cardiac diseases etc., to the human who is spraying these fertilizers. Sometimes, dermal exposure happens when your skin is exposed to pesticides. This can cause irritation or burns. In order to avoid this risk and spray the fertilizers/pesticides uniformly, we came up with the idea of automatic fertilizer/pesticide sprayer using a drone. It is also known as UAV i.e. Unmanned Aerial Vehicle. More recently quadcopter designs become popular in unmanned aerial vehicle (UAV) research. These vehicles use an electronic control system and electronic sensors which stabilize the aircraft. The Sprayer movement is controlled by DC motor at low velocity, up & down direction according to the plant height. It can also cover larger areas of fields while spraying fertilizers/pesticides in a short span of time when compared to a manual sprayer. The proposed system can be remotely operated through any electronic device like mobile, laptop etc.

Indexed Terms- UAV, Agricultural Drone, ArduPilot, Automatic Spraying

I. INTRODUCTION

About 70-80% of India's population either directly or indirectly depends upon the farming and agriculture. [1] But most of the farming techniques used by Indian farmers are traditional. Farmers who perform manual labour in areas treated where they can face major exposure to pesticides from a direct spray, by contact with pesticide residues on the crop or soil or droplet drift from the neighbouring fields. [2] This kind of indirect exposure is often underestimated. The dermal and inhalation of pesticides are the most common routes of entry. Farmers who mix pesticides and spray them using mechanical equipment like back sprayer are having high chances of getting exposed directly to the spills and splashes because of faulty or missing protective equipment, or even drift.. According to WHO estimate, there are 3 million cases of pesticide poisons in each year and up to 200,000 deaths, primarily in developing countries. [2]

Use of UAVs can help in reducing these deaths and other health problems. [3] An unmanned aerial vehicle (UAV) has a wide range of applications in fields of agriculture, forestry etc. [4] for observing, transporting loads and sensing. [5] UAVs are operated remotely either by telemetry or other protocols, [6] where the operator maintains visual contact with the aircraft along pre-determined paths using GPS and other guiding sensors like compass. A commercial UAV was used to spray crops and the work rate and spray deposition measured for a number of spray techniques and spray volume application rates. [7] Recent works in the field of UAVs has addressed the requirement for low volume application, in consideration of limited payload capacity, has been emphasized. [8]

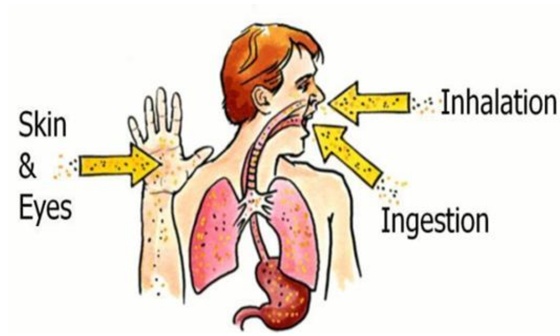

Fig: Possible ways for pesticides to enter the body

II. COMPONENT SPECIFICATION AND SYSTEM ARCHITECHURE

A. Hardware

The components which are used in our system are described in detail with their working and operation as follows

1. Brushless Motor:

Brushless Motors are similar to normal DC motors. These brushless motors have three coils on the inner of the motor, which is fixed to the mounting. These motors are called as brushless motors because the brush which takes care of switching the power direction in the coils is absent. We have used is of 980 KV rating brushless DC motors which can operate at 7.4-14.8 volts where each motor produces a thrust of 880 grams.

2. ESC (Electronic Speed Control):

The brushless motors are normally 3 phases. Therefore, direct supply of DC power will not turn the motors on. That is why the Electronic Speed Controllers (ESC) comes into picture. The ESC generates three high frequency signals which have different but controllable phases. They continually generate frequencies to keep the motor turning.

3. Propellers:

On each of the brushless motor is mounted with a propeller. The 4 propellers are actually not identical in rotation. The motor torque and the law of physics will make the Quadcopter spin around itself if all the propellers were rotating the same way, without any chance of stabilizing it. The larger diameter and pitch the more thrust the propeller can generate. Here we are using 10*4.5" propellers.

4. Battery:

This complete automated unmanned aerial vehicle runs on a battery. It is recommended to use a LiPo (Lithium Polymer) battery because of less weight. Here we are going to use a 11.2V, 5200mAh LiPo battery.

5. GPS (Global Positioning System):

We are using Global Positioning System device, so that the quadcopter can navigate from one position to other. This is also used in automation purpose also. With the help of GPS, we create the waypoint (predefined path) to fly the quadcopter autonomously. Here we are using UBLOX 7M GPS with in-built compass. This is can take up to seven points for flying.

6. ArduPilot:

This ardupilot is a microcontroller specially designed and developed for building autonomous vehicles. Flight movement is controlled by using the mission planner software on a laptop or mission maker application via smartphone. It also includes the accelerometer, gyro meter and an in-built compass. Microcontroller is the brain of the quadcopter as it is responsible for all actions it performs, from take-off and landing to autonomous flight of quadcopter.

7. 2.4 GHz RC Transmitter and Receiver:

We are using a 2.4GHz range Radio Controller Transmitter and Receiver, so that if the quadcopter loses its connection with the base control, we can gain control over it using this remote control and operate it manually.

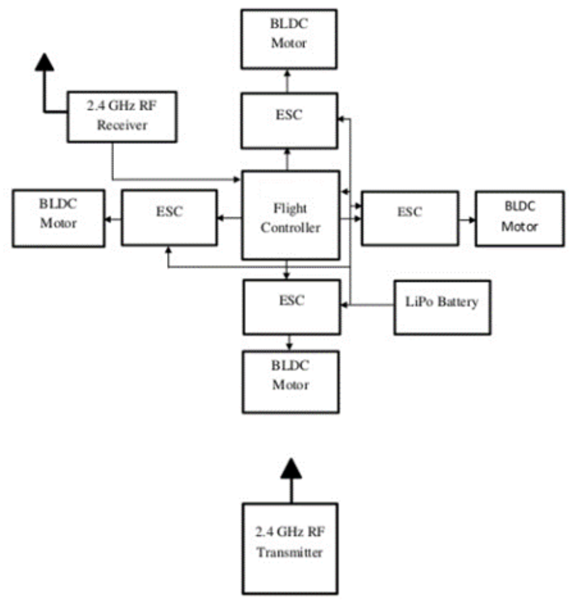

Fig: Drone architecture

B. Software

The main purpose of using the software is to make the quadcopter as autonomous.

1. Mission Planner software:

Mission planner is open source developer software which plays a vital role in the operation of the quadcopter. This software is mainly used to program the micro controller according to our requirement and create waypoints which will direct the quadcopter through a prescribed path. Interfacing the RC transmitter and receiver can allow us to control the quadcopter manually also. The RC transmitter and receiver are to ensure that no damage occurs to UAV.

2. Features of Mission Planner software:

The following are few important operations that can be performed using mission planner software.

- It loads firmware onto APM, configures in different ways to use the APM chip from different aerial and ground vehicles.
- APM setting can be configured depending on the kind of frame configuration that is being used.
- It has full ground station support for monitoring missions and sending in flight commands. We can download mission log files which can be used for later analysis.
- With current point and click way point entry using google maps, autopilot can be controlled.

3. Mission Maker application:

This application is similar to the controlling part of the software. The main advantage of using this application is, we can control the UAV through smartphone.

III. EXISTING METHODS

The following are few mostly used strategies for spraying pesticides and fertilizers.

3.1 BACKPACK (KNAPSACK) SPRAYER:

This consists of a tank, a pump, a lance (for single nozzles) or boom (for multiple nozzles). The tanks contain a mixture of water (or another liquid chemical carrier, such as fertilizer) and chemical which will be sprayed in the form of droplets. The size of droplets can be as large as rain-type drops or as small as almost-invisible particles. This conversion is accomplished by forcing the water and chemical mixture through a spray nozzle under applied pressure. The size of droplets can be altered by using different kinds of nozzles, or by altering the applied pressure, or a combination of both. Large droplets have the advantage of being less susceptible to spray drift, but they require more water per unit of land covered. Small droplets are most likely to make maximize contact with a target organism due to static electricity, but still wind conditions are required. But, in this type of spraying, the labour has to carry the complete weight of the pesticides tank which causes severe back pain and other physical problems to labour and hence this method reduces the human capacity. [9]

Fig: Man spraying fertilizers using a backpack sprayer

3.2 MOTORCYCLE DRIVEN MULTI-PURPOSE FARMING DEVICE (BULLET SANTI):

In 1994, Mansukhbhai Ambabhai Jagani, developed an attachment for a motorbike to get a multi-purpose tool bar. It addresses the twin problems of farmers in Saurashtra namely paucity of labours and shortage of bullocks. This motor cycle driven plough (Bullet Santi) can be used to carry out various farming operations like furrow opening, sowing, inter-culturing and spraying operations. This is more efficient and cost-effective for small-sized farms. [10] But there disadvantage of this method is that the labour can be exposed to the harmful effects of fertilizers either directly or indirectly if proper precautions were not taken.

Fig: Farmer using Bullet Santi to spray fertilizers in the field

IV. PROPOSED METHOD AND WORKING

We chose to automate UAV instead of operating it manually, because this can save time and field monitoring can also become easy. For this purpose, we picked 913 MHz telemetry as 433MHz is not an accepted range in India for making commercial purpose drones. By utilizing a progression of various separation measure/imaging hardware like Pi Camera, drones can record the plant condition while spraying which will be useful in identifying the crop diseases and plant monitoring.

Instruments like sensors that utilize ultrasonic resounding enables drone to identify the crop location so that fertilizers are sprayed correctly on the target amid flight. Since this is a pilot project and a prototype, it is presently attainable for automatons to fly at sufficiently low heights to splash pesticides and target specific segments of a field to appropriate it in likely manner.

We made use of a dedicated micro controller called ArduPilot for automation of drone which is designed specifically for unmanned aerial vehicle applications. This micro controller is programmed with the help of development software called Mission Planner which can run on either on Windows or Linux. To automate this we can either use a computer with Mission Planner software or a smartphone with Mission Maker application as a ground base station. These applications can help us directing the drone by uploading the way points through which it has to travel before taking of the vehicle.

Initially open the mission planner application and connect to the quadcopter via telemetry. Once you are connected to the quadcopter, we set the waypoints by clicking on new mission option. After way points are selected, the designed mission should be uploaded to the micro controller. The micro controller processes the information and waits for the command to run the mission. Now we turn on the APM 2.8 by arming it. Then the APM 2.8 subtracts the current location (taken from the GPS) from the waypoint which given in the mission. According to the result, the quadcopter moves in desired direction with the help of Electronic Speed Control (ESC), Global Positioning System (GPS) and Compass. Every motor carries ¼ of the weight of Quadcopter. Hence building a quadcopter with live control as well as autopilot capabilities that is versatile enough requires tackling several problems. Using Raspberry Pi, we are going to record the crops while spraying to check whether the targeted crops receive the required amount of fertilizers. We have used the motor as brushless motor, because they can achieve high torque. The aircraft must have an adequate payload capability as well as stabilization and localization capability. The movement of the quadcopter is controlled via 4 motors. The motor on the backward should rotate in a higher RPM than the front motors so that the quadcopter can move in forward direction. This way the movement of the quadcopter is controlled. In case if the quadcopter loses its connection with the ground station, we can operate the drone manually using the receiver.

Fig 1: Image of proposed drone model

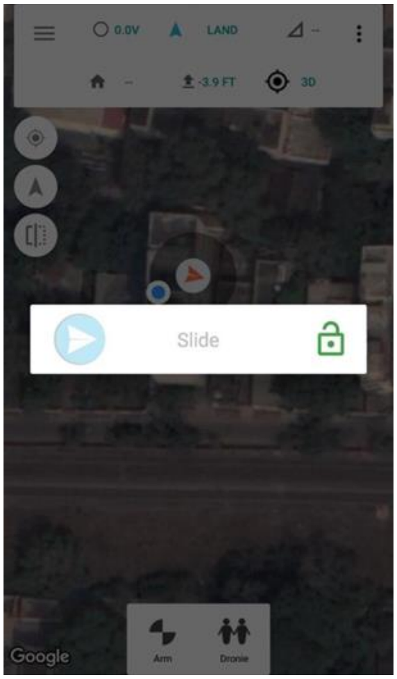

Fig 2: Arming the quadcopter

V. RESULTS AND DISCUSSIONS

Fig 1: Creating waypoints on mission maker application

Fig 2: Take off point of drone (point 1)

Fig 3: Final point of path (point 6)

The vehicle started from point 1 as shown in the map and traversed the path and reached the point 6. After reaching the point 6, it again changed its direction and returned to the home point which is point 1. We choose a nose which sprays water at a rate of 5L/min. Since this is a pilot project, we chose the tank quantity as 1 litre. It is to be noted that this prototype should not be given altitude input above 4 ft. giving which can lose the contact with the ground station.

CONCLUSION

We can further extend this project by implementing tree surveillance by using image processing techniques like histogram matching algorithms, clustering methods to discover the rate of ripeness (evolution) of fruits, crop aging could be checked. With the assistance of few parameters like shape of the fruit, colour-shade of fruit skin, we can achieve the above goals. This helps agriculturists by decreasing their manual work, by saving time, resources and money. Additionally, UAVs can be utilized for the purpose of surveillance in large farm areas by installing a signalling device on the borderline of the plantation area so that the drone can travel to the prescribed line and move to every plant/tree and note the health of that particular plant/tree, which is more helpful in monitoring health details of each and every plant/tree in the entire farm land area. After a real world model is built and distributed throughout country with a subsidy, the Indian agriculture will be revolutionized and drastic improvement in the agriculture sector as well as in the health conditions of the farmers can be seen.

REFERENCES

[1] FAO in India, India at glance. Available online: http://www.fao.org/india/fao-in-india/india-at-a-glance/en/ (Accessed on: 1 April 2020).

[2] Bulletin on World Health Organisation, Acute pesticide poisoning, a proposed classification tool. Related information available on: https://www.who.int/bulletin/volumes/86/3/07-041814/en/ (Accessed on 1 April 2020).

[3] Paolo Tripicchio and Massimo Satler. "Towards Smart Farming and Sustainable Agriculture with Drones". 2015 International Conference on

Intelligent Environments.978-1-4673-6654-0/15 $31.00 © 2015 IEEE. DOI 10.1109/IE.2015.29.

[4] Marthinus Reinecke Tania Prinsloo.”The influence of drone monitoring on crop health and harvest size” .978-1-5386-3831- 6/17/$31.00 ©2017 IEEE.

[5] Alex, C. and Vijaychandra, A. (2016). Autonomous cloud based drone system for disaster response and mitigation. In Robotics and Automation for Humanitarian Applications (RAHA), 2016 International Conference on, pages 1–4. IEEE.

[6] Motlagh, N. H., Taleb, T., and Arouk, O. (2016). Lowaltitude unmanned aerial vehicles-based internet of things services: Comprehensive survey and future perspectives. IEEE Internet of Things Journal, 3(6):899– 922.

[7] Tripicchio, P., Satler, M., Dabisias, G., Ruffaldi, E., and Avizzano, C. A. (2015). Towards smart farming and sustainable agriculture with drones. In Intelligent Environments (IE), 2015 International Conference on, pages 140–143. IEEE.

[8] Deepak Murugan, AkankshaGarg, and Dharmendra Singh.”Development of an Adaptive Approach for Precision Agriculture Monitoring with Drone and Satellite Data”.939-1404 © 2017 IEEE.

[9] Advantages and disadvantages of liquid pesticides applicators, Published on: KFVS12 Available online on: https://www.kfvs12.com/story/2032039/advantages-and-disadvantages-of-liquid-pesticide-applicators/ (Accessed on 4 April 2020).

[10] Bullet Santi. Published by: National Innovation Foundation – India. Available on: http://nif.org.in/innovation/Bullet_-Driven_Santi/87. (Accessed on 4 April 2020).