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Review Article

Use of Drones in Agriculture

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Abstract

Drones are unmanned aerial vehicle (UAV) and are remote controlled or GPS driven that can be operated for various applications in agriculture e.g., aerial crop monitoring, uniform pesticide spraying, seed distribution and aerial watering. Day by day use of drones and IOT technologies in agriculture are gaining momentum. In USA almost 84% farmers are using drones on regular basis daily or weekly. With this, new tech aviation companies are shaping which are providing drones on rental basis or providing their services on contract basis. In this article authors have tried to explore and analyze drones as future technology to assist agricultural activities and working towards better and efficient use of scarce resources in agriculture.

Introduction

With the advent of artificial intelligence and machine learning (AIML), computer vision (CV) is the most promising branch of it that is increasingly used to automate the human actions with precise accuracy and efficiency. Drones are using CV technology to control all actions during its projected flight and interactive actions and feedback with ground station. Drones can play a vital role in scaling and managing large farmlands [1].

Drone and its control

There are various ways to categorize drones, base on altitude and takeoff they are defined as Micro Air Vehicle, vertical takeoff and landing, low altitude short and long endurance, medium and high-altitude long endurance drones. Based on application requirements, appropriate model of drone can be selected.

In agriculture and in disaster relief drones are deployed which are semi-autonomous. They have to fly according to the definition of a flight path in terms of waypoints and flight altitude. Such drones are embedded on board a positioning measurement system for knowing its position with respect to the waypoints. Also, an altimeter is embedded for flying at constant flight altitudes. Payloads of drones include multispectral camera, thermal camera, RGB camera and light detection and ranging (LiDAR) systems.

Capabilities of agricultural drones include:

1. Drone has to fly according to waypoints definition.
2. It has to control its flight altitude.
3. Drone has to sense and avoid obstacles during the flight.
4. It has to land according to the state of the battery automatically.
5. Acquired images have to be stabilized with a gimbal.

Figure 1: Drone in agriculture.

The flight control system of semi-autonomous drones is split into two parts; an outer loop or reference generator. It takes into account the position to reach which is expressed in terms of waypoint (xr, yr and ψr) and flight altitude (zr).

It generates a command signal defined in terms of (ψ˙c, Ωc, θc and φc). An inner loop which uses these commands and provides an output to control the speeds of propeller motors ωi (i from 1 to the number of propellers) [2].

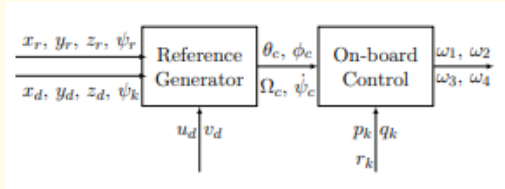

Figure 2: Control scheme in drone. Subscript c indicates the commands, r indicates the references, d indicates the drone variables and k indicates the sensors and data fusion outputs.

These inner and outer loops work together in a cascade control system and inner loop (on-board) needs to regulate at a rate faster than the outer loop (that usually runs on a ground control station). Figures 3 describe the overall system and the on-board control architecture, respectively. There are many ways to carry out the reference, from heuristic techniques to advanced model-based methods that uses an accurate dynamical model of the drone. Traditional Proportional Integral Derivative (PID) controllers might benefit from a detailed model. The dynamical model of drone can be easily derived by introducing the so-called inertial (OFI) and body (OABC) reference systems. Reference generator is position coordinates (xr, yr, zr and ψr) that copter aims to reach by tuning the desired attitude (θc and φc), heading velocity (ψ˙ c) and thrust (Ωc) of the drone, later used as references for the on-board control system.

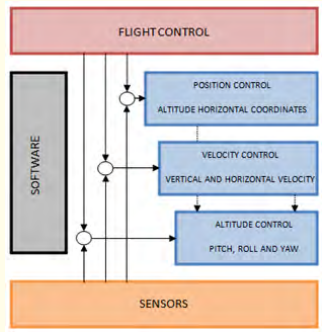

Figure 3: Typical control loops for multi rotor light aerial vehicle.

Agriculture

In most of the developed and developing nations, agriculture is widely mechanized and using latest tools and machines. Tractors, thrashers, monoculture, harvester, baler, hay rake, land Imprinter and drip irrigation are supporting equipment used on fields. Drone is the latest addition in this category and most rapidly spreading tool in agriculture.

Figure 4: Arial view of farms by drone.

Recently there is a growing concern about the justified use of pesticides and water for irrigation. Similarly use of chemical fertilizers is highly debatable for sustainable agriculture.

Automated crop phenotyping is the most promising area of drone technology. Aerial pictures taken with the help of drones and using CV for analysis can be used in various ways. Weed identification, water stress, structural stress, abiotic stress, pest and disease stress are some of them. Let us discuss the role of drones that they can play in agriculture [3].

1. Farmland and soil assessment: For precise farming we require accurate and diverse data regarding type of soil, humidity in soil, fertilizer supplements needed for a crop. Drones can be used for collecting this data and provide for analysis and conclusion on these points [4].
2. Plant establishment and seed distribution: Like rice cultivation it is required to establish saplings of the crop in a very precise manner and drones are successfully used for it, resulting in time and labor saving. Similarly seed spraying can also be done with high accuracy and lower cost and wastage.
3. Precise insecticide spray: Drones can be used for precise insecticide spray. It has been observed that it saves time, reduces quantity of insecticide and precise and uniform spray in the farmland. It also reduces excess insecticide in environment.
4. Crop monitoring for health: It is difficult to have a bird's view of the farmland from the ground level. Drones provide this biggest advantage to the farmer that he can have a quick, detailed and regular view and see the status of the crop on regular interval. Thus, he can prevent plant diseases, lack of soil elements, locust, insects with timely detection and applying remedial measures. Thus insecticide, fungicide and pesticide can be used with minimum quantity and reducing pollution due to excessive quantity.
5. Irrigation management: For best crop outcome, you need exact and on surface application of water for maintaining the appropriate level of moisture in soil. Thus, less water, maximum surface area and least application cost results into better economics for the farmer.
6. Livestock management: In animal husbandry which is increasingly becoming very important source of income for the farmer, drone plays an important role with RFID tags on livestock. Remote sensing fencing and virtual boundaries are very good applications for control during animal grazing and routine roaming.

Conclusion

From the above discussion we arrive to the conclusion that drones are very promising technology and can be used in agriculture for

increasing the productivity. However, being the latest technology, it still lacks legislature support and regulations. In situation of labor shortage and large farmlands, drones are very useful and cost effective.

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