Review of Applications of UAVs in Agriculture

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Abstract: The world population keeps increasing rapidly which makes the food supply become more and more important. Some schemes to deal with the challenge is utilizing the information and communication services with higher efficiency, and increasing the production of the fertilizer which has the capability to increase the productivity of the cropper. The UAV is a flexible vehicle in many fields nowadays. Military use UAVs in target acquirement and area monitoring. Those features of UAVs also can be used in agriculture development.

Keywords: UAVS, Drone, Precision Agriculture.

1. Introduction

In the recent year, there are an 80 percent increasement in investment in agriculture. Since the population increment is significant, the final goal of this enormous investment is to archive 70% growth in agricultural productivity. With the planting area has been enlarged a lot, the management of the plants and applying fertilizer become much more intricate time-consuming. The present concept of agriculture is called precision agriculture. It is based on observing, measuring, and responding to manage the plants. Precision agriculture increases the productivity of the crops, increase fertilizer placement efficiency and decreases the wasting of water in the field, but it needs to cooperate with the monitoring equipment. The UAV is an unmanned aerial vehicle which can be equipped with various sensors and be programmed to do a specific task. Through the programming, UAVs can achieve the atomization of agriculture production. The UAV is capable to operate image processing which can be utilized in agriculture appropriately to monitor the growth, procedure of fertilizing, and disease detection. Under the systematic operation in agriculture, the information of the growth environment and state of the plants helps farmer to make critical decision and management of crops.

2. Types of the UAV

Regularly, the wrights of the UAV are lower than 25 kilograms, they do not require a human to fly since they can be controlled remotely. UAVs can finish the survey in the wide region easily, also the images and in-depth situation analysis. The weight of the UAV is an essential factor to distinguish the type between them. The very heavy UAV are usually utilized for military purposes. This kind of UAV can hold enough amount of fuel for a long flight and can be used in various applies on. In agriculture, the weight of UAVs is around 5 to 50 kilograms. There are usually two kinds of UAVs that have been used for agriculture, fixed wing, and multi-copter UAVs [1]. The fixed wing UAVs are robust and can work under harsh weather conditions and have a longer flight time than multi-copter UAVs. But the price of fixed wing UAVs is often expensive, and it requires a larger space to take off and land. Muti-copter UAVs have a wilder application scope, and they are easy to fly. Not only can the multi-copter UAVs can measure the environment temperature, but also can work in precision spraying, fertilizing, and seeding. The fixed wing UAV and multi-copter UAV are shown in Figure 1 and Figure 2.

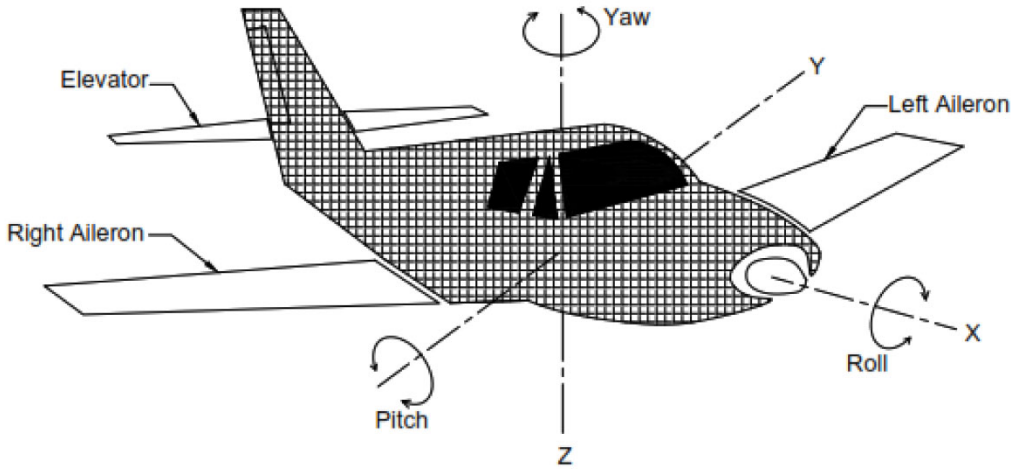

Figure 1. Fixed wing.

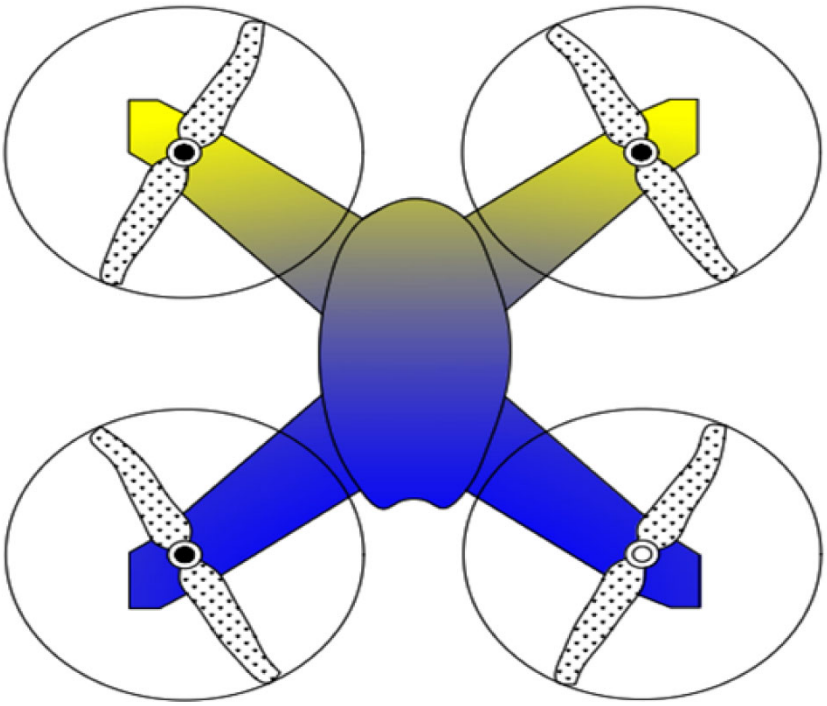

Figure 2. Quad copter.

3. Application in agriculture

3.1 Weed mapping

One application of the UAV in agriculture which is most popular is weed mapping [2]. Weed is the plant that can cause the undesirable effect on growth of the crops. Weed will share the resource which is important for the growth of crops like water, space, and the nutrition contained by the soil. In traditional farming, the solution is that spraying the herbicides into the whole field even in the area without weeds. This high-cost solution not just affects the growth and harvest of the crops, but also cause a serious impact on the living environment for plants. In precision agriculture, site specific weed management is used. Instead of spraying the whole file, specific site weed management partitions the filed base on the cover rate of the weed, and spraying different quantities of herbicides on each part based on the local environment. The cost has been reduced and less effect on the crops

can be achieved by this way. Specific site weed management requires a clear plot showing the cover rate of the weed to ensure that the precious spaying can be completed for each region. The UAV can collect the image data of the whole field to generate the precious map of weed covering [3]. Through data processing, the most needed spraying region can be found conveniently.

3.2 Crops Health Monitoring

UAVs also can be used in monitoring the health condition of the plants [4]. Crop health is very important in agriculture since the health condition of the plants influences the yield and the quality of the crops. The disease takes the experts much time to monitor, and it may cause serious economic loss. One way to avoid the disease is to keep inspecting and preventing the potential disease from spreading. Another way is to spray the pesticides periodically on certain days. However, both methods take time and occur a high cost. Spraying too many pesticides may also influent the health of the crops and decrease the productivity of the plants [5]. UAV is capable to achieve disease detection. By being equipped with a camera, the image analysis can be done by the UAV. The disease may cause a change on the surface of the plants which can be detected by the camera. In the early stage, the UAV can find the specific plants with the disease and notice farmers solve it, which prevent the disease from spreading and the economic loss. During the treatment of infection, UAV can also do the spraying for the specific target and keep monitoring the procedure of the treatment.

3.3 The method of image processing of UAV in agriculture

The control strategy is based on detecting the coverage ratio of weed from 0 per ceper cent to15 percent. The experimental example of the field contains sunflower and weed shows the process and accuracy of the image processing of UAV. The study site is located at Monclova farm in Seville province, southern Spain [6]. The experimental regions are the two sunflower fields on the farm. The size of the sunflower is 6 kg per hectare, 0.7 meters apart in row. The ground is flat, and sunflowers are infested naturally with the weeds such as mustard, bindweed, and pigweed. The first step is collecting the coordinate of each corn of the field by the GPS which will be used to design the planning of the route of UAV. Programming enables the UAV could collect the overlap of the map from different altitude and degree. Two model md4-1000 quadcopter UAVs equipped with different two cameras to collect the image from the different altitudes and degrees. Md4-1000 operates at the speed of 12 meter/s, the height it can reach is 1000 meter and the endurance are 88 minutes. The remote control has the range of 500 meter also it can be extended up to 40km using GPS waypoint navigation The low-cost camera Olympus PEN E-PM1 was used in the experiment. The 12-megapixel images can be captured by the camera based on the RBG value for each pixel. The entire area of the experimental sunflower field can by collected with the imagery with a sequence of 30 percent side-lap and 60 percent forward-lap. The image mosaicking is the essential step before doing the image analysis. The UAV flight collect 49 samples of 1 x 1 square meter of the field. 12 of them are used to simplify the process of image mosaic process and orthogonalization. By using the Agisoft PhotoScan Professional Edition to mosaic the overlap images [7], the whole 3D model can be built based on the calculation of the shooting coordinate and altitude from the UAV. Once the 3D model has completed, the high-quality landscape photo shows the sunflower row can be resulted. The OBIS algorithm will be used in the image analysis focusing on the sunflowers and weeds. It combined the features of the different plants, hierarchical position, spectral values to recognize the weed and sunflowers. The OBIS algorithm also does the analysis based on the arrangement order of the plants, the plants out of the order also be recognized as weeds. The result shows in Figure 3.

Figure 3. Image processing of the sunflower field

Part a is the partial view of the mosaiced image of the field. Part b shows the details of the square frame. Part c shows the results of the image analysis, the green part stands for the sunflower, and the purple part shows the distribution of the weeds.

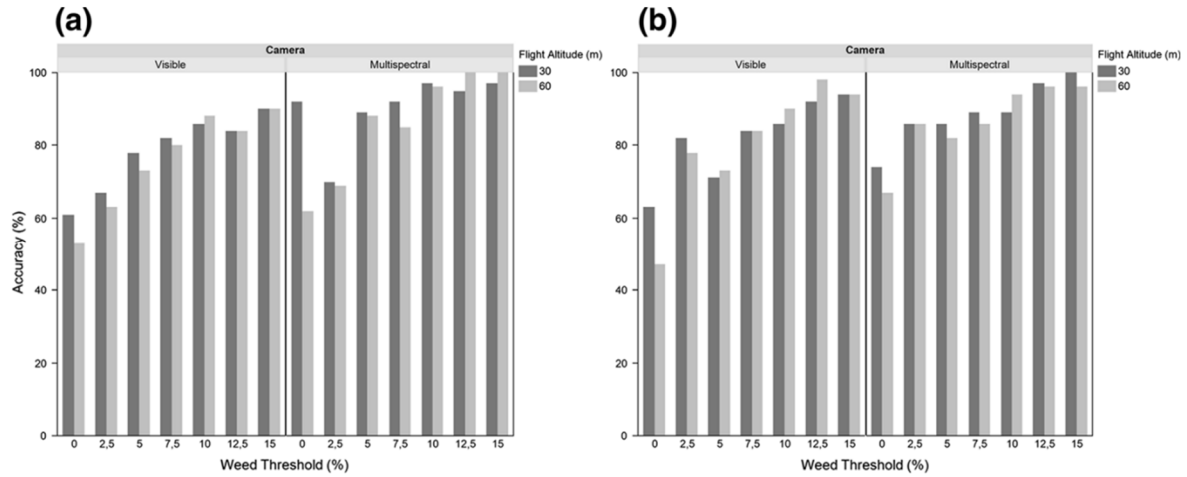

Figure 4. Accuracy of the weed map

Figure 4 shows the experimental result of accuracy in two sunflower fields by the image analysis. The accuracy is all above 50 percent on each height and threshold value [8]. The accuracy increased with the high threshold value which stands for the region that has the high weed coverage rate. It is reasonable that the weed can be detected with a higher possibility with the big amount of it. However, the accuracy is kind of low in the region with the 0 percent of weed threshold value since the weed pitch is tiny and hard to recognize. The experiment data shows that UAV detection for weeds is capable. The pesticides can be saved by the weed mapping of UAV [9]. In the health monitoring for the crop, the operation method is similar but focuses more on the horizontal view of the crops.

4. Limitation

Although the application of UAVs in agriculture is various, limitation also exists. The data processing and machine learning is the most important ability of the UVA should have to do the mapping and field control. The software and program written in the UAV are complex and they should be developed by experts. It may take the farmer quite a lot of money to complete those necessary setups. Another limitation of UAVs is their work time. The flight time of UAV is often short since the flying and sensor operation consumes power at a high rate, the battery of the UAV is

also limited by its small size. The common work time for most UAVs used in agriculture rounds from 12 minutes to 20 minutes since both the flight and the sensor cost energy [10]. In the harsh weather, the work time could be affected by the environment and become less durable. The power consumption of the sensor needs to be decreased or the model of UAV which can carry the larger battery is demanded. The improvement room of the robustness and durability of UVA is still great by the technology. The benefits brought from the UVA to agriculture can be much more by the new updates.

5. Conclusion

The most application of the UAV in agriculture is monitoring the growth of crops. UAV can find the environment which may affect the growth of crops most and notice farmer in a short time. It reduces the environment pollution caused by the agriculture medicine and ensures the yield and quality of the plants. By continuous monitoring, the cost of disease prevention of the plants reduces a lot, also prevents the huge economic loss in agriculture. UAV could be equipped with multiple types of sensors, their application of it can be broad and more utilization can be improved for agriculture in the future.

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