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Use of Unmanned Aerial Vehicles in Agricultural Operations.

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Abstract: *The present day sees a large increase in the number of populations worldwide. This increasing number also raises the concern of fulfillment of the need of food to the people. To cope up with this number, improvised and efficient agriculture plays a vital role. Agriculture sector is one of the most promising & challenging sectors today. In developing countries like India, more than 50 % of the rural population depends upon the agriculture. The production of the crop is highly dependent upon theclimate, which is out of the human control. The yield of the crops also depends upon the various other factors such as fertilizers, pesticides, insecticides, plant diseases, etc. which can be controlled through proper treatment and analysis of the crops. In the present paper a research review is carried about using Unmanned Aerial Vehicles (UAVs) in Agricultural Operations, contributing to the smart agricultural practices for better and quality crop yielding for farmers.*

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I. INTRODUCTION:

Agriculture feeds the population of the word. Agriculture in India constitutes to more than 50% of the occupation. It serves to be the backbone of the Indian economy. Considering the statistics, researches and projected studies, it is not only essential but now a necessity to improve the productivity & efficiency of the agriculture by practicing safe cultivation using advanced engineering and latest technologies.

The modern-day farmer faces various challengesduring the crop cycles. These include climate changes, resistant weeds and pests, and water scarcity. On the farm trials, yield measurements, forage quality evaluation, weed control effectiveness, and plant nutrient status are some of the popular data collection methods used to measure these risks. These methods rely on gadgets such as portable meters, test strips, manual stand counts, chlorophyll meters, seed sampling, and colour charts for plant tissues. These gadgets have a limited accuracy, are cumbersome to operate, require an investment in the needed human expert to operate them and therefore subject to human error.

With the advent of agribusiness technology, these challenges are now addressed and precisely mitigated using high-tech data collection tools such as UAVs or drones. [https://www.farmmanagement.pro/the-use-of-unmanned-aerial-vehicle-to-collect-crop-data/]

Many countries have already started using smart technologies for smart and fine agriculture, amongst which the Unmanned Aerial Vehicles (UAVs) is an extensively used. UAVs are nothing but "Drones" in common language. Inclusion of such technologies gives farmers the potential to fight the major and minor challenges, reducing working hours, resulting in the increased stability, measurement accuracy, resulting in better productivity. UAVs are less expensive and easy to operate. Their applications include pesticide, fertilizers, insecticide prospecting and spraying, seed planting/bowing, weed recognition, fertility assessment, crop and field monitoring and forecasting. Adding of sensors and cameras to the UAVs make them more advanced and potential. This advancement allows them in achieving remote sensing of the field. In 2020, amid coronavirus pandemic, spraying systems through UAVs highly contributed in sanitization. Same methodology is useful for agriculture also. However, there are also many challenges and limitations faced by agricultural UAVs such as battery efficiency, low flight time, long distance communication issue, weight, etc. In order to select the suitable UAV in agriculture, numerous models are analyzed and summarized by the experts. This paper holds the discussion about the best suitable UAV for agriculture, its applications, advantages, challenges & limitations. This paper also mentions about the future scope to the farmers or the agriculture sector for betterment of the crops.

II. LITERATURE SURVEY:

Krukute et al. (2018)reported that the drones can be used for smart agriculture by using Atmega 644P efficiently. Mogili and Deepak (2018) reviewedtheapplication of drone systems in precision agriculture and stated that the use of UAVs is possible where there is no human intervention, which are useful for spraying, monitoring and supervision process based on the imaginganalysis of geographical conditions.Ahirwar et al. (2019) have discussed about the working mechanism, types and their various applications of UAVs in agricultural operations. Norasma et al. (2019) stated that agricultural applications can be done by using UAVs which is very important for food security in order to increase the yield of productivity for the increasing population of the world. Mone et al. (2017) reported that the agriculture drones can be effectively used for spraying fertilizers and pesticides. The authors have given details about implementation of agriculture drone for automatic spraying mechanism with precautions to avoid health effects of pesticides and fertilizers as well as cost effective technology using components such as PIC micro-controller for the control of agriculture robots. Meivel et al. (2016) discussed the use of multispectral cameras which are used to captured remote sensing images to identify the green field as well as the edges of crop area by using quadcopter UAV based fertilizer and pesticide spraying system by using QGIS software for the purpose of analyzing the remote sensing images. Korlahalli et al. (2017) have given details about the wireless drone system based on flight-controlled board (FCB), GPS, brushless DC motor, electronic speed control (ESC), wireless transceiver, frame, propellers & battery, etc. They used flight-controller board for controlling the function of the drone such as movement, lifting, positioning, etc. FCB is programmed for handling different sensors such as GPS, barometer, accelerometer, gyroscope, etc. and components such as motors and programmed on annual and autonomous mode. There are many agriculture applications that use UAV technologies now-a-days such as Aero-virement (Goktogan et al, 2010), X-copter (Shim et al, 2009) VIPetro (Primicerio et al, 2012) Field copter (Wal et al, 2013) and Sensefly eBee. The imagery from the sensors needs to be processed by using correct software and combining each piece of photos which are captured using UAVs.In the present study, a research review is being carried out for application UAV systems for agricultural operations .

III. MATERIALS AND METHODS:

Unmanned Aerial Vehicles or Drones:

An UAV or a drone is a flying electronic device that can fly a pre-set course with the help of GPS co-ordinates and mechatronic technology.It is an aircraft without a human pilot abordwhich can also be manually piloted in case of a fault or a dangerous situation. The devices also consist of normal radio controls [Ahirwar et al, 2019].

Focusing on the UAV technologies being used for Precision Agriculture (PA), the types of Unmanned Aerial Vehicles can be divided into five basic categories, based on their design characteristics (see Figure 1) [Tsouros et al, 2019]

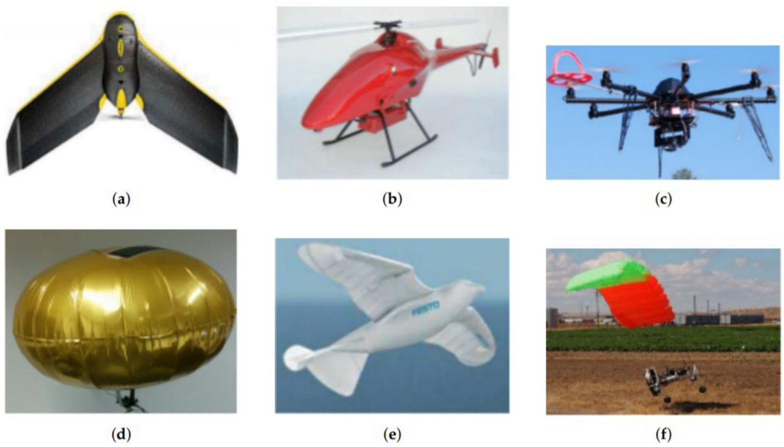


Figure 1: (a) Fixed wing (eBee) (b) helicopter (Hornet Maxi) (c) octocopter (d) blimp e) flapping-wing (SmartBird) (f) parafoil-wing (Tetracam)

1. **Fixed-wing (Fig. 1a):** These are unmanned planes with wings that require a runway to take off from the ground or a catapult. This type of UAVs has high endurance as well as the ability to fly at high speeds. In addition, fixed-wing UAVs have the ability to cover large areas on each flight and can carry more payload. However, they are more expensive than the other types. In the works reviewed, more than 20 % farmers used solar power fixed-wing UAVs found to be very promising technology [Oettershagen et al, 2016; Tsouros et al, 2019]. Solar-powered UAVs offer significantly increased flight times because they exploit and store the sun's energy during the day. This is the reason that they are preferred for long-endurance operations.

2. **Rotary-wing (Fig. 1c):** The rotary-wing UAVS, also called rotorcrafts or Vertical Take-Off and Landing (VTOL), offer the advantages of steady flying at one place while keeping the manoeuvrability attribute [Tsouros et al, 2019]. These features are useful for many different types of missions. However, they cannot fly at very high speed or stay in the air for a long time. They are generally the most widely used UAVs in all kinds of applications, but especially in Precision Agriculture. One reason for this is the fact that they present lower cost

compared to the other types of UAVs. In addition, this type of UAVs is suitable when the monitored crops are not very large, which is usually the case.

A UAV of this type may be: • An unmanned helicopter: They include main and tail rotors such as conventional helicopters. More than 5 % of the farmers used this type. • Multi-rotor: This category includes rotary-wing UAVs with four or more rotors (quadcopter, hexacopter, octocopter, etc.). These aircraft are generally more stable in flight than unmanned helicopters. Overall, more than 70 % of the farmers used this type of UAVs.

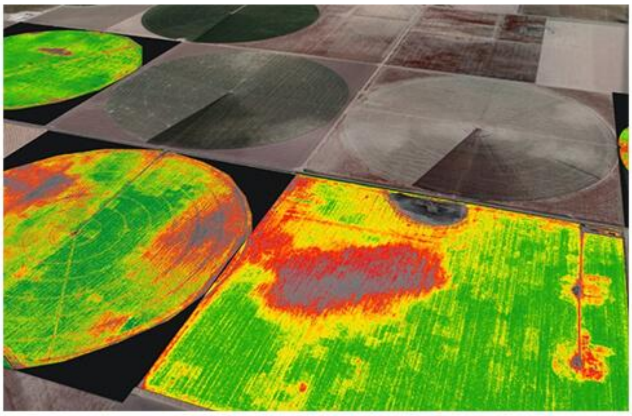
3. **Blimps (Fig. 1d):** This type of UAV is lighter than air, has high endurance, flies at low speeds and is generally larger in size compared to the other types. Their manufacturing characteristics allows them to remain in the air even in the event of a total loss of power, while being considered relatively safe in the event of a collision. Usually, they are not used in Precision Agriculture applications. In the recent works reviewed, no application was found using this type of UAVs [Tsouros et al, 2019].

4. **Flapping wing (Fig. 1e)**: These UAVs are very small and they have flexible, shaped little wings inspired by the way birds and insects fly. They are not often used in Precision Agriculture as they require high energy consumption due to their size. No work was found in the literature review using this type of UAVs.

5. **Parafoil-wing (Fig. 1f):** Usually aircrafts of this type have one or more propellers at the back in order to control the course of their flight, but at the same time for harnessing the power of the air to fly without consuming much energy. They are also capable of carrying a larger payload. They are not usually exploited for PA applications. Only 2% of the works analysed use this type. In addition to the above classification, UAVs can also be categorized according to their size. However, the categorization used in this study is more common, as it takes into account more factors affecting the performance of UAVs and their use in Precision Agriculture.

The majority of the recent works in Precision Agriculture use multi-rotor UAVs. This is mainly due to the fact that in most applications the area under consideration is not very large. For this reason, it is not necessary to use UAVs with high speed and the ability to cover large areas in a few flights, such as fixed-wing UAVs. Thus, rotary-wing aircraft are preferred because of the advantages such aseasy to operate, slower speeds, ability to manoeuvre and relatively lower cost. These advantages provide greater opportunities for collecting information from crops through imaging, which is the main use of UAVs in vegetation monitoring. In the cases where the monitoring area is relatively large, fixed-wing aircraft are preferred, which enable the monitoring of the entire area in a short time [Tsouros et al, 2019].

From Raw Data to Useful Information: Flying over the field, the drone takes high-resolution pictures with a camera or sensor. Based on a measured parameter, these images are captured in different bands from visible (colour), near-infrared to infrared spectrum. The collected images are raw data which requires further interpretation. Immediately after capturing the image, the images are directly sent to the cloud/software where different prescription maps are created depending on the operation the farmer wants to perform on the field. The maps can then be uploaded to the specific farm equipment which will adjust the number of inputs (seeds, fertilizers, pesticides) that would need to be applied to the field accordingly. [https://blog.agrivi.com/post/powerful-role-of-drones-in-agriculture april 2018]

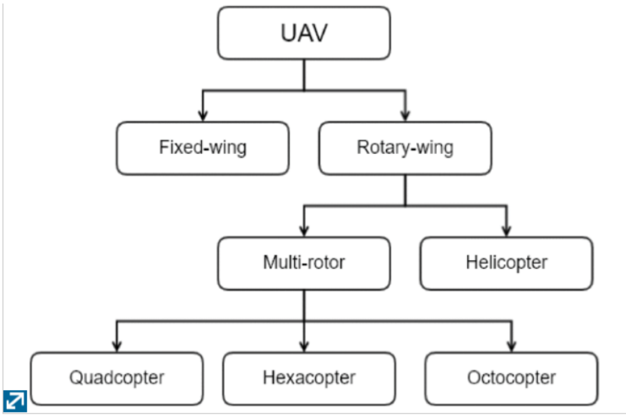


Images captured by a drone give field map

A typical image of an UAV or a drone in Indian agriculture.

Aerial Platforms: Types of UAV

UAVs are basically based on two types of platforms. Fixed type and Rotary type, which are then categorized into subtypes as shown in the figure below.



Working principle of a UAV or drone: The 4 propellers of a drone or a quadcopter are fixed and vertically oriented. Each propeller has a variable and independent speed which allows a full range of movements. There are various parts or components that contribute to a fully functional UAV or drone or a quadcopter. **Chassis –** the skeleton of the drone to which all the parts are fixed to. **Propellers** – they principally effect the load the drone can carry, the speed with which they can fly and the speed it can man oeuvre. **Motors** – 1 / propeller generally rated in "KV". **Electronic Speed Controller (ESC), Flight controller, Radio receiver, Battery,** and with addition to this there can be added various sensors and cameras for further advancement [Ahirwar et al, 2019].

Mechanism: An UAV or a drone is controlled manually with the help of the radio controller, which controls the propeller. Various buttons on the controller allows the movement in different direction and the trim button allows the trim to be adjusted to balance the drone. The live footage of the onboard camera (if any) or the sensor data can also be seen with the help of a screen [Ahirwar et al, 2019].

Applications: The unmanned aerial vehicles or drones find their applications in various domains. Them being Military, Delivery services, Security and law enforcement, Search and rescue, Films and television industries, Agriculture, Disaster management, Wildlife monitoring.

Agricultural applications of UAVs or drones:

Crop Health Assessment: Imaging ability of the UAVs make it possible to click the pictures or live images to view the situation of crops, track changes and indicate their health [CAB Abstracts]. Responding to the disease as soon as possible saves entire crops. In India it is seen that most of the farmers face the issue of weaker crops due to lack of proper and timely treatment. This results in lesser selling hence reducing the income for the farmers. UAVs will drastically help in timely crop health assessment.

Soil Analysis:UAVs can be instrumental at the start of the crop cycle. Their ability to produce detailed maps for early soil analysis which eventually help in deciding the crop pattern and planting [Ahirwar et al, 2019]. It can also provide the data for irrigation and nitrogen level detection post early soil analysis [Kurkute et al, 2018].

Pesticides / Insecticides / Fertilizers Spraying: Field scanning and identifying the exact need of the correct amount liquid required to the crops and spraying them accordingly by also maintaining sufficient distance from ground so as to avoid the penetration of the liquids into the ground water. All these aspects can be taken care of smoothly with the help of UAVs.

Irrigation:UAVs with the help of the hyper-spectral, multi-spectral and thermal sensors can identify the dry patches or parts of the fieldare to be taken care of. Vegetation index can also be taken care of with the help of UAVs, once the crops are growing, which can give indication of crop health and heat emission from the pant.

Crop Monitoring:UAVs are capable of the observing the crops from different indices [Mogili and Deepak, 2018]. Vast field and lack of proper monitoring is farmer's biggest obstacle. UAVs can cover hectors of field in single flight. The camera attached can record the reflectance of the vegetation canopy.

IV. CONCLUSION:

The production of agriculture is very important for the food security in the world. In the present study the review was carried out for the agricultural field management which can be improved by using UAVs and increase the yield of the productivity in order to feed the increasing population. The sensors and the types of the UAV cannot solve all problems in the field but it can help for some specific issues in agriculture. The integrated technology will help the farmers in field operations. In the past decade latest technologies are included into the precision agriculture to improve the productivity of the crop. These technologies are useful where human intervention is not possible for spraying of pesticides and scarcity of labor. The proposed system describes the crop monitoring through the multispectral camera mounted on the UAV. In one flight camera takes pictures and analyze by geographic indicators. Based on the results the UAVs are able to cover up hectors of field in single flight for crop monitoring and it could be easy to find the area where to spray the pesticides on the infected areas. This can also reduce the wasting of water and chemicals. UAVs will drastically help in timely crop health assessment, with the help of hyper spectral, multi spectral and thermal sensors it can identify the dry patches or parts of the field are taken care of. UAV in precision agriculture is still in its early stage and may have a further development both in technology and agriculture applications.

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REFERENCES:

[1]. https://www.farmmanagement.pro/the-use-of-unmanned-aerial-vehicle-to-collect-crop-data/

[2]. S.R. Kurkute, B. D. Deore, Payal Kasar, Megha Bhamare, Mayuri Sahane, "Drones for Smart Agriculture: A Technical Report", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887 Volume 6 Issue IV, April 2018

[3]. UM Rao Mogili1 and B B V L Deepak, Review on "Application of Drone Systems in Precision Agriculture", Procedia Computer Science 133 (2018) 502–509 Available online at www.sciencedirect.com - 2018

[4]. C Y N Norasma1, M A Fadzilah, N A Roslin, Z W N Zanariah, Z Tarmidi, F S Candra, "Unmanned Aerial Vehicle Applications in Agriculture", IOP Conf. Series: Materials Science and Engineering506 (2019) 012063 IOP Publishing doi:10.1088/1757-899X/506/1/012063 – 2019

[5]. S. Ahirwar, R. Swarnkar, S. Bhukya and G. Namwade, "Application of Drone in Agriculture", International Journal of Current Microbiology and Applied Sciences ISSN: 2319-7706 Volume 8 Number 01 (2019)

[6]. CAB Abstracts hot topics, "Unmanned aerial vehicles for precision agriculture", www.cabi.org/bookshop/subscribe/

[7]. Vergouw, Nagel, Bondt, Custers, "The Future of Drone Use, Drone Technology: Types, Payloads, Applications, Frequency Spectrum Issues and Future Developments", WODC, Research Centre of the Ministry of Security and Justice, 2016

[8]. Dimosthenis C. Tsouros, Stamatia Bibi and Panagiotis G. Sarigiannidis, "A Review on UAV-Based Applications for Precision Agriculture", co-located with IEEE DCOSS 2019. Received: 7 October 2019; Accepted: 7 November 2019; Published: 11 November 2019

[9]. https://en.wikipedia.org/wiki/Unmanned_aerial_vehicle

[10]. https://www.theuav.com/

[11]. Prof. P. P. Mone, Chavhan Priyanka Shivaji, Jagtap Komal Tanaji, Nimbalkar Aishwarya Satish "Agriculture Drone for Spraying Fertilizer and Pesticides", International Journal of Research Trends and Innovation, (ISSN 2456-3315, Volume 2, Issue 6). September 2017.

[12]. Prof. K. B. Korlahalli, Mazhar Ahmed Hangal, Nitin Jituri, Prakash Francis Rego, Sachin M. Raykar, "An Automatically Controlled Drone Based Aerial Pesticide Sprayer", Project Reference No.39S_BE_0564.

[13]. S. Meivel M.E, Dr. R. Maguteeswaran Ph.D., N. Gandhiraj B.E, G. Sreenivasan Ph.D., "Quadcopter UAV Based Fertilizer and Pesticides Spraying System", International Academic Research Journal of Engineering Sciences, ISSN No. 2414-6242, Volume 1,Issue 1, February 2016.

[14]. Göktoğan A, Sukkarieh S, Bryson M, Randle J, Lupton T, and Hung C (2010). A Rotary-wing Unmanned Air Vehicle for Aquatic Weed Surveillance and Management. Journal of Intelligent and Robotic Systems, 467-484.

[15]. Shim D, Han J S, and Yeo H T (2009). A Development of Unmanned Helicopters for Industrial Applications. Journal of Intelligent and Robotic Systems, 407-421.
[16]. Primicerio J, Gennaro S, Fiorillo E, Genesio L, Lugato E, Matese A, and Vaccari F (2012). A flexible unmanned aerial vehicle for precision agriculture. Precision Agriculture, 517-523.
[17]. Wal T, Abma B, Viguria A, Prévinaire E, Zarco-Tejada P, Serruys P, and Voet P (2013). Fieldcopter: unmanned aerial systems for crop monitoring services. Precision agriculture, 169-175.

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