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Agriculture drones: A modern breakthrough in precision agriculture

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Abstract

Drones commonly referred, as UAVs are mostly associated with military, industry and other specialized operations but with recent developments in area of sensors and Information Technology in last two decades the scope of drones has been widened to other areas like Agriculture. The drones manufactured these days are becoming smarter by integrating open source technology, smart sensors, better integration, more flight time, tracking down criminals, detecting forest and other disaster areas. The aim of this research paper is to highlight the importance of drones in agriculture and elaborate top drones available in market for Agriculture monitoring and observation for yielding better crop quality and preventing fields from any sort of damage.

Keywords: *Agriculture Drones, UAVs, Drones*

Mathematical Subject Classification: *68T40*

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1. Introduction

Unmanned Aerial Vehicles (UAVs) [1] [3] also commonly known as Drones are regarded as pilotless aircraft systems used in diverse applications like Industrial monitoring, photography, battlefield surveillance, air ambulance, package delivery and many more. Drones operated by single-operated pilot, are regarded as short distance flying objects, and on the other hand, there are long distance flying drones known for flying at High Altitude. Considering past few years, there has been considerable development in the area of drones for all possible kinds. Drones provide sophisticated advantages as compared to anything else like ease of use, accurate monitoring of those areas which are difficult to reach by man, illegal activities tracing, forest fire observations and surveillance of crop yields of large agriculture farms.

Over the past 10-15 years, with high-end technology transformations from radio controlled model hobbyist's airplanes, drones are integrated with variety of functions. RF planes could not be controlled unless not seen by human eye but modern drones are fitted with GPS and camera which can be used by pilot to track and fly the drones to larger distances via making use of GPS enabled smartphones and even portable LCD enabled remote controls.

With the integration of Wi-Fi technology in drones in form of First Person View (FPV), drones can be integrated with HD cameras like GoPro, DJI, Parrot and many others to stream real-time video of flight over smartphone or tablet.

Currently, almost 85% of drone technology is mainly utilized by military and rest 15% by civilians for diverse applications. However,

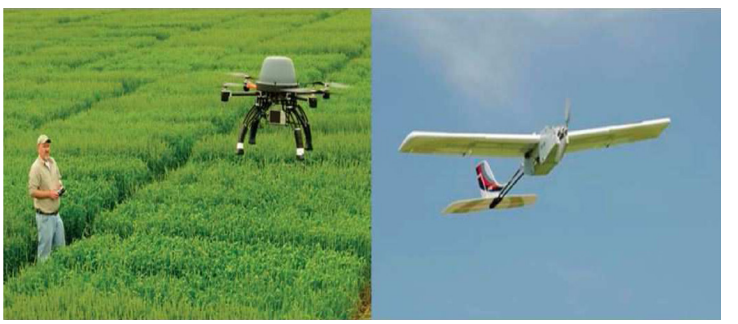

Figure 1

Rotary Copter Drone being operated in Agriculture Field (Left) and Fixed Wing Drone (Right)

with certain restrictions and no fly zones, drones are also banned in some countries like India to fly over public places and government buildings. Association of Unmanned Aerial Systems International reported an annual growth of 85-92% every year especially in the upcoming market of Agriculture. Lots of researchers and drones manufacturing companies are either coming up or in process of releasing varied models of Drones especially made up for agriculture.

Drones can be categorized in two categories: Fixed Wing Airplanes and Rotary Motor Helicopters

Each of these drones has its own advantages and limitations. The fixed wing drones can fly at higher speeds ranging from 25-45 mph and can cover the range of 500 to 750 acres per hour depending on the battery. Rotary motor drones on the other hand can hover and focus on specific problem in real world and can fly over constant speed. They suffer from limited battery life and can take off and land off safely in small confined areas and are absolutely best for starters to learn Drone Flying.

In this Research Paper, we primarily focus on importance of implementing and using Drones/UAV's in Agriculture and what additional benefits farmers can have on crop yield by using drones. Section 2 will cover application cum advantages of drones in agriculture; Section 3 highlights top drones, available specifically for agriculture. Section 4 covers conclusion and future scope.

2. Drones in Agriculture [2]

Currently, the practical applications for drones are expanding from hobbyists to industries and other areas like photography etc. It is expected that Drones market can touch $200 billion by year 2020. Among various promising areas, Agriculture is regarded as one of the most important area where different varieties with feature packed facilities are required overcoming several challenges of farmers for better crop yield [4][5][6].

The following are the various Applications cum Advantages of using drones in Agriculture being deployed for day to day Agriculture tasks:

1. *Agriculture Farm Analysis:* Drones are high end reliable instruments flying in the sky and can be used by farmers to inspect the farm condition at the beginning of any crop year. Drones generate 3-D maps for soil analysis which is useful for farmers to take care during seed ploughing. Soil and field analysis via drones also provides data useful for irrigation and managing nitrogen level of fields for better crop growth.

2. *Time Saving:* Farmers with tons of hectares of land finds difficult to reach each nook and corner of field for inspection time to time. Drones does this task without any hiccup as farmers can do regular air monitoring of field to know the status of their crops at regular intervals of time.
3. *Higher Agriculture Yield:* The precision application of pesticides, water and use of fertilizers accurately monitored by drone will in turn increase the yield and overall quality can be taken care off.
4. *GIS Mapping Integration:* GIS Mapping has already proven its worth throughout the agriculture industry to manage resources, yield increase, input cost management, better business management and more. With GIS mapping integrated with Drones, the farmers can draw field borders for accurate flight pattern.
5. *Imaging of Crop Health Status:* With drones, crop health imaging can be done using Infrared, NVDI and multispectral sensors making the farmers better track the health of crop, transpiration rates and sunlight absorption rates etc.

3. Drones for Precision Agriculture [5]

In this section, Agriculture Drones available in market are discussed along with their technical specifications.

3.1 *Honeycomb AgDrone System*

The AgDrone System by Honeycomb Company is regarded as most sophisticated drone for Agriculture covering 600-800 acres of field every hour flying at 400 feet. The wings of the drone are composed of Kevlar

Figure 2

Honeycomb AgDrone

Table 1
Technical Specifications of Honeycomb AgDrone.

Parameters	Values
Drone type	Fixed Wing
Material	Kevlar Exoskeleton
Wingspan and Battery	49in; 8000 mAh LiPo
Coverage	858 Acres
Trigger Method	Automatic Dual Camera Electrical Signal
Flight Specifications	Cruise Speed: 46 km/hr Max Speed: 82 km/hr

[Src: http://www.honeycombcorp.com/agdrone-system]

Fiber composite, same material being used in Bulletproof jackets making the drone rugged for all conditions and in turn making it durable, versatile and powerful for agriculture

3.2 *DJI Matrice 100*

DJI Matrice 100 is regarded as the Best Quadcopter based Drone for Agriculture with dual battery support, which increases almost 40 minutes of flight times. Special features of this drone include GPS, Flight Controller, DJI Lightbridge which is regarded as Advanced Flight Navigation System to do complex tasks and easy to operate in all environmental conditions.

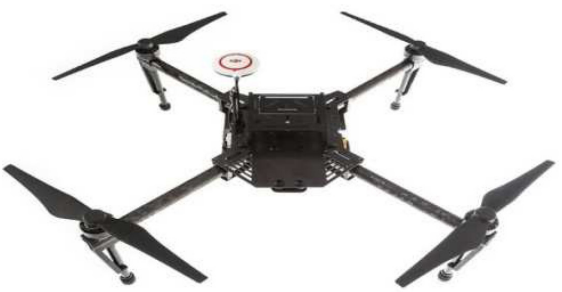

Figure 3
DJI Matrice 100 Quadcopter Drone

Table 2
Technical Specifications of DJI Matrice 100 Quadcopter Drone

Parameters	Values
Drone type	Fixed Wing with Intelligent Flight Battery
Battery	5700 mAh LiPo 6S
Video Output	USB, HDMI-Mini
Flight Specifications	Max Speed: 5m/s (Ascent) Max Speed: 4m/s (Descent)
Operating Temperature	-10°c to 40°c

[Src: http://www.dji.com/matrice100]

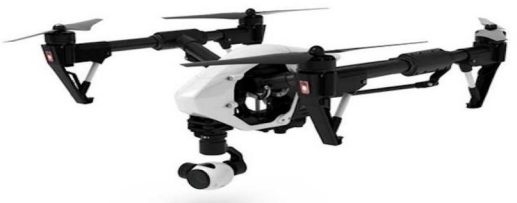

Figure 4
DJI T600

3.3 *DJI T600 Inspire 1 [7]*

The DJI T600 Inspire Quadcopter is another powerful carbon fiber material finish Agriculture drone known for its fast charging. It specially features 4K Video recording, individual flight and camera control and provides easy navigational capabilities.

Table 3
Technical Specifications of DJI T600 Drone

Parameters	Values
Material	Carbon Fiber
Interface Type	Detachable
Battery	4500 mAh LiPo 6s

Contd...

Camera Features	Image: 4000x3000 ISO Range: 100-3200 (Video) 100-1600 (Photo) Modes (Photography): Single, Burst, Auto Exposure, Time-Lapse Modes (Video): UHD, FHD, HD File Formats: JPEG, DNG, MP4, MOV Memory Card: 64GB (Max)
Flight Operations	Max Speed: 5 m/s (Ascent) Max Speed: 4 m/s (Descent)
Flight Time	18 min / 40 Min with Additional Battery

[Src: http://www.dji.com/inspire-1]

3.4 *Agras MG-1- DJI*

Agras MG-1 – DJI is ultimate octocopter designed to assisting farmers to spray large areas of farmland with pesticides, insecticides or Fertilizers. The unique features of this drone is that MG-1 is compatible to carry upto 10KG of liquid payloads and can cover 4000-6000 m2 area in just 10 minutes which is regarded as 70 times faster as compared to manual spraying. MG-1 has fully sealed body and consists of efficient, integrated centrifugal cooling system to keep the air flowing to each part of the Drone during flight time. MG-1 is equipped with 4 nozzles for accurate spraying of fertilizer in the field and is fully equipped with three types of Flight Mode: Smart, Manual Plus Mode and Manual Mode depending on specifications of field. MG-1 features Y-type folding structure without making use of any additional tools [8].

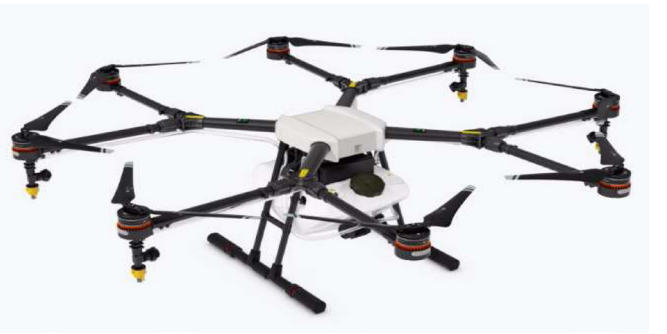

Figure 5
Agras MG-1-DJI

Table 4
Technical Specification of Agras MG-1-DJI

Parameters	Values
Material	High Performance Engineered Plastics
Liquid Tank	10 Kg (Payload), 10 L (Volume)
Nozzle	4
Battery	MG-12000
Flight Parameters	Max Take Off Weight: 24.5 Kg Max Operating Speed: 8m/s Max Flying Speed: 22 m/s Operating Temperature: 0 to 40 °C

[Src: https://www.dji.com/mg-1]

3.5 *EBEE SQ- SenseFly*

The EBEE SQ is High Performance agriculture drone especially designed for Crop Monitoring from planting to harvest to assist farmers in better crop yield. This drone is fully integrated and highly precise and has multispectral sensor capable for capturing data across four non-visible bands along with RGB imagery in just single flight. The drone provides larger coverage as compared to other quadcopter drones and has automatic 3D flight planning. The drone is fully compatible with Pix4dmapper AG mapping software to create NVDI maps for crop fields and identify problem areas during flight.

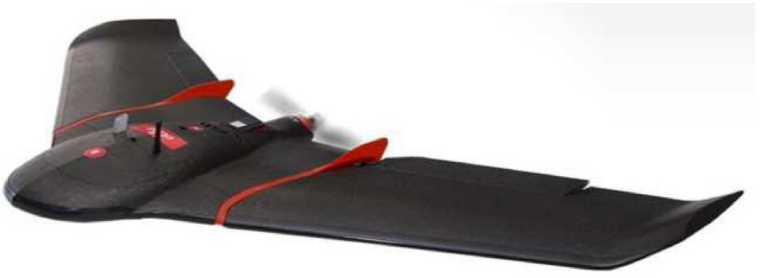

Figure 6
EBEE SQ-SenseFly

Table 5

Technical Specifications of EBEE SQ-Sense Fly

Parameters	Values
Drone Type	Detachable Wings with Low-Noise, Brushless and Electric Motor
Flight Operations	Max Flight Time: 55 Minutes Linear Landing with ~ 5m Flight Planning Software: eMotion Ag
Sensors	4 Spectral Sensors, GPS, IMU, Magnetometer, SD Card
Camera	4-1.2 MP Spectral Camera 1fps 16MP RGB Camera

[Src: https://www.sensefly.com/drones/ebee-sq.html]

3.6 *Lancaster 5 Precision Hawk*

Lancaster 5 Precision Hawk is among one of the Autonomous Drones especially designed for Agriculture and Environmental Monitoring and has capability to optimize flight plan to collect data in most sophisticated way. With the integration of smart flight controls, the drone adjusts accordingly to payloads and unpredictable environmental conditions to bring back the best data of flight operation. Consists of Plug and Play sensors to deliver more data to the user as per the user application specifications. The drone has in built sensors like Humidity, Temperature, Pressure as well as incident light. As the drone supports open source technology, it gives wide open doors for researchers to contribute their own sensor code.

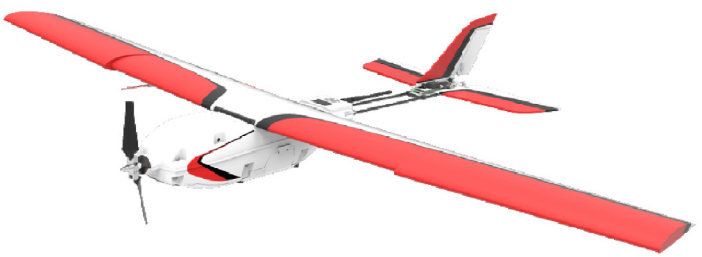

Figure 7

Lancaster 5 Precision Hawk

Table 6
Technical Specifications of Lancaster 5 Precision Hawk

Parameters	Values
CPU	720 MHz Dual Core Linux CPU
Interfaces	Analog, Digital, Wi-Fi, Ethernet, USB
Wing	Fixed Wing with Single Electric Motor
Battery	7000 mAhr
Flight Parameters	Altitude: 2500 m Max Speed: 79 km/hr Survey Span: 50-300 m
Operating Temperature	40ºC

[Src: http://www.precisionhawk.com/lancaster]

3.7 *SOLO AGCO Edition*

The SOLO AGCO Edition is regarded as till date most optimal solution via drone for better farm management. The drone is fully autonomous in flying and provides better high-resolution aerial maps to assist the farmers in monitoring field condition efficiently. It makes use of intuitive mission planning and cloud based high-resolution mapping software to increase flight efficiency. Drone makes use of Agribotix imaging and analysis software for precision agriculture.

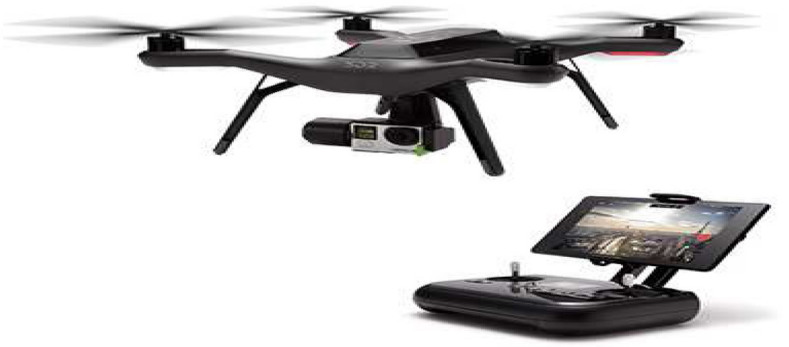

Figure 8
SOLO AGCO Edition

Table 7
Technical Specifications of SOLO AGCO Edition

Parameters	Values
Flight Controller	PIXHAWK 2
Material	Self-Tightening Glass-Fortified Nylon Props
CPU	1 GHz Onboard Computer
Video	Full HD Streaming to Mobile Device
Flight Parameters	Max Speed: 55 mph Flight Time: 25 Minutes Auto Take Off and Landing
Camera	2 Cameras- GoPro 4 Hero4 Silver for RGB NIR GoPro
Others	Field Health Mapping (NDVI) Management Zone Mapping

[SRC: https://www.pages05.net/agco/SOLO_UAV/contact/]

4. Conclusion

The market for Drones is expanding day by day from the last two decades and they have brought a significant revolution in the area of Industry, Military, Agriculture and many more. This study investigated the importance of drones in Agriculture and has highlighted the various drones available for diverse agriculture applications along with technical specifications. The paper is regarded as eye-opener for Industry and Agriculture for development and integration of more drones for making Agriculture tasks better and in turn yielding best crop quality in near future

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