Agricultural Drones

Overview

An unmanned aerial vehicle (UAV), commonly known as a drone, or an unmanned aircraft system (UAS), and also referred by several other names, is an aircraft without a human pilot aboard.

The flight of UAVs may be controlled with various kinds of autonomy: either by a given degree of remote control from an operator, located on the ground or in another vehicle, or fully autonomously, by onboard computers.

Applicable Industries

- Agriculture, Forestry & Fishing
- Food & Beverage
- Logistics

Applicable Functions

- Environmental Health & Safety
- Procurement & Sourcing
- Quality Assurance

Market Size

Estimate A	Agricultural Drones market worth $3.69 billion by 2022. Source: iot.do
Estimate B	The worldwide market for agricultural drones is $494 million in 2016. Source: iot.do
Estimate C	The market for agricultural drones is expected to grow from $864.4 million in 2016 to $4.2 billion in 2022, at a CAGR of 30.19% during the forecast period. Source: Market and Market

User Viewpoint

Business Value

How does this use case impact an organization's performance?

Using drones for crop surveillance can drastically increase farm crop yields while minimizing the cost of walking the fields or airplane fly-over filming. According to iot.do, the benefits of digital farming are higher productivity and more efficient use of land, water, and fertilizer. Drones offer the potential for addressing several major challenges, for example, soil and field analysis, planting, crop spraying, irrigation and health assessment.

There are many benefits of agricultural drones and these are:

- Increased yields: Drones can be used to find yield limiting problems with a lot of ease.

- Saves time: Drones can be used to save time while scouting for crops.

- Return on investment: Drones can improve the ROI by giving the information that the farmers need on time.

- Ease of use: Drones are relatively easy to set up and use.

- Crop health imaging: Drones can help farmers to see the real health of the plants by seeing the amount of sunlight being absorbed by the plant.

- Water efficiency and other environmental benefits: Thermal cameras are able to detect cooler, well-watered field regions as well as dry hot patches. Farmers can use this data to adjust field irrigation and avoid wasting excess water.

(Source: agrotechnomarket.com)

Key Performance Indicators

How is the success of the system measured for users and for the business?

The best way to measure the KPI for agricultural drones is to measure the increased yields compared to the past when drones were not being used. Furthermore, the time and energy saved by using drones can also be a metric that can be measured.

System Capabilities & Requirements

What are the typical capabilities in this use case?

Following are six ways aerial and ground-based drones will be used throughout the crop cycle (technologyreview.com):

1) Soil and field analysis: Drones produce precise 3-D maps for early soil analysis, useful in planning seed planting patterns. After planting, drone-driven soil analysis provides data for irrigation and nitrogen-level management.

2) Planting: Startups have created drone-planting systems that achieve an uptake rate of 75 percent and decrease planting costs by 85 percent.

3) Crop spraying: Drones can scan the ground and spray the correct amount of liquid, modulating distance from the ground and spraying in real time for even coverage. The result: increased efficiency with a reduction of in the number of chemicals penetrating into groundwater.

4) Crop monitoring: Time-series animations can show the precise development of a crop and reveal production inefficiencies, enabling better crop management.

5) Irrigation: Drones with hyperspectral, multispectral, or thermal sensors can identify which parts of a field are dry or need improvements.

6) Health assessment: By scanning a crop using both visible and near-infrared light, drone-carried devices can identify which plants reflect different amounts of green light and NIR light.

Positive performance requires relatively long uptime for the drones. It also requires reliable setup for comprehensive field analytics.

Deployment Environment

Where is the 'edge' of the solution deployed?
Agricultural drones are mostly used in crop farms.

Stakeholder Viewpoint

Investment Decision Makers & Influencers

Which organizations, departments, or individuals typically makes an investment decision and allocates budget?
The owners of the fields are the investment decision makers for the purchasing of agricultural drones. They decide to purchase it to help them with farming and increasing yields.

System Operators

Which organizations, departments, or individuals are responsible for operating and maintaining the system?
The farmers are typically the drone system operators. The drones are easy to operate and the farmers usually do not have an IT team to operate the drones for them.

System End Users

Who are the regular users of the system?
End users are farmers who use the drones to help them with farming and irrigation. End users can also be the service companies who provide agriculture drone services to farmers.

External Data Users

Which external stakeholders are provided with limited access to the data?
Drone manufacturers and industrial researchers could be the external data users to improve their products.

Technology Viewpoint

Sensors

What sensors are typically used to provide data into the IoT system, and which factors define their deployment?

Drones collect information largely based on the light reflected by the crop below. For agricultural purposes, using a specific type of sensor can help growers collect data that indicates where issues exist so that they can take appropriate action. There are two types of sensors in question when using drones: Thermal and Hyper-spectral sensors.?

- Thermal sensors can read the radiated temperature of an object, and some of the newest models are light enough to be carried by a small drone. A thermal sensor might help identify how plants are using water, as those with access to more water appear cooler in an image. The challenge is that these temperature variations are minor and can be difficult to distinguish from the other factors that might heat or cool the plant, such as breezes, sun exposure, etc.?

- Hyper-spectral sensors record many wavelengths of both visible and invisible light. Although the size and price of these cameras are coming down, they are still large and expensive. The promise of these sensors is that they might be able to identify the specific type of plant merely by measuring the color of light that it reflects, which would make it easy to pick out things like herbicide-resistant weeds. However, calibrating these cameras to work on a low-flying drone in a farm environment where the light conditions vary as much as they do is a problem that needs to be solved before hyper-spectral cameras can deliver.

Analytics

What types of analysis are typically used to transform data into actionable information?

When a drone collects data over a field, the camera takes several hundred still images as it flies a “lawnmower” pattern back and forth across the field. These images then performed to make the results useful. Other agriculture drones provide data as NDVI DVI, water trough map, health management zones, elevation contours, emergence uniformity, leaf area index, digital surface model, crop height, Google Earth export etc.

Cloud & Edge Platforms

What factors define the cloud and edge platforms used to integrate the solution?

Using cloud computing to crunch numbers from soil sensors, satellite imagery, weather stations and other inputs to make farms more efficient can be used to improve the systems.

Connectivity

What factors define the connectivity solutions used to provide both device-to-device and device-to-cloud communication?

It varies based on the what kind of flight controller the drone uses. In most cases, the data communication protocols are ZigBee mesh network.

User Interface

What factors define the interfaces available to the system users?

Recently, a Graphical User Interface (GUI) and several NUI methods are studied and implemented, along with computer vision techniques, in a single software framework for aerial robotics called Aerostack which allows for intuitive and natural human-quadrotor interaction in indoor GPS-denied environments. These strategies include speech, body position, hand gesture and visual marker interactions used to directly command tasks to the drone. The NUIs presented are based on devices like the Leap Motion Controller, microphones and small size monocular onboard cameras which are unnoticeable to the user. Thanks to this UCD perspective, the users can choose the most intuitive and effective type of interaction for their application. Additionally, the strategies proposed to allow for multi-modal interaction between multiple users and the drone by being able to integrate several of these interfaces in one single application as is shown in various real flight experiments performed with non-expert users.

Source: (Natural User Interfaces for Human-Drone Multi-Modal Interaction)

Data Viewpoint

Data Sources

How is data obtained by the system?

The data is collected from the field where the agricultural drone flies on. This data is then relayed to the cloud which gives a good representation of the situation at the farm, including the overall health of the soil, crop's growth and yield.

Data Types

What data points are typically collected by the system?

1) UAV position (GPS latitude and longitude), 2) UAV altitude (GPS altitude above sea level), 3) current navigation mode, 4) magnetometer status, 5) barometer status, 6) motor power, 7) momentary status of all the radio control channels, and 8) limit values of flight altitude, distance and speed.

Implementation Viewpoint

Business & Organizational Challenges

What business challenges could impact deployment?

There are various challenges people face when using agricultural drones:

1) Too much data: One of the primary challenges for farmers is that they do not understand how to filter out all the data as there is too much of it.

2) Precision and cost: Drones are expensive and there needs to be a professional who analyzes the data which will be costly.

Integration Challenges

What integration challenges could impact deployment?

Integrating the drone technology into a farm is not that difficult, however in order to be best utilize the drone, a data analyst is needed to gather and analyze the data, which might be a difficult part of the integration.

Installation Challenges

What installation challenges could impact deployment?

Farming occurs in seasons, according to uavcoach.com so even though the farmers might have excellent ideas to implement, they may have to wait sometime before the drones can get up and run.

And even if the farmers can hypothetically implement right now, it's still only as actionable as the crew they have and the labor hours they can put toward that improvement (and, when you consider the hours required simply for routine maintenance tasks, adding new tasks may prove challenging).

IoT ONE Use Case

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