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SOME ASPECTS OF DRONE CONTRIBUTION TO PRECISION AGRICULTURE

Donca Gheorghe*

*University of Oradea, Faculty of Environmental Protection, 26 G. Magheru st., 410048 Oradea, Romania, e-mail: donca.gheorghe@gmail.com

Abstract

The pressure to produce more food has led to the need for identification of applicable solutions, to solve, to improve the sustainability of production processes and accelerate innovation in the agriculture. These solutions based on the technical revolution can be characterized by the Farming 4.0 concept.

This concept is primarily based on the application of precision agriculture methods with the help of new technical achievements such as robots, UAVs (Unmanned Aerial Vehicles), IoT (Internet of Things), AI (Artificial Intelligence), Big Data and Cloud.

Among the important technological achievements, we list the automatic steering based on GPS, autonomous tractors and agricultural machines, the replacement of the thermal motors with electric motors, using batteries as the main source of energy, robots and drones for agriculture, direct communication between agricultural machines and centralization of all information in Cloud-based software applications.

This article gives a brief overview of the achievements based on the use of UAVs in agriculture and tries to synthesize the main future directions.

Key words: drone, UAVs, Farming 4.0, IoT, precision agriculture.

INTRODUCTION

The Department of Economic and Social Affairs, Population Division, of the United Nations, (United Nations, 2017) has predicted that the global population will reach 8.55 billion people by 2030 and almost 10 billion people by 2050. In order to feed this growing population, according to FAO, food production must increase with 70 percent by 2050 and a 60 percent increase in demand for high quality protein such as milk, meat and eggs.

Agriculture is energy intensive and the pressure to produce more food requires more energy, an increasingly costly input to the production process.

The early part of the past decade saw the rise of data-driven technologies and insights, going from basic analytics tools to the significantly more powerful business intelligence (BI) suite, which boasts the ability to aggregate an organization’s data and display it, in an easily digestible format. The massive leap in analytics capacity meant that data became a valuable asset, and organizations are happy to invest millions into applications and tools if it means they can use it successfully for ROI acceleration.

One of the important sources of data is the aerial images captured by agricultural drones. This data must be correlated with other data obtained from field sensors or other sources.

MATERIAL AND METHOD

Satellites have been used for a decade to monitor large croplands and forestry but a new level of precision and flexibility has been obtained with the use of Unmanned Aerial Vehicles (UAVs). For example, Sen4CAP software is an advanced solution for agriculture monitoring, commissioned by the European Space Agency, gives a direct access to the complete Copernicus Sentinel satellite data repository and dynamically scalable processing opportunities.

Drones however can monitor crops much more accurately, frequently and affordably, delivering higher quality data that are updated regularly to provide insight into crop development and highlight inefficient or ineffective practices. The ability to assess the health of a crop quickly and precisely can be invaluable for farmers. If a bacterial or fungal infection are identified, early detection allows quick action to be taken in order to remedy the issue

The global drone regulations database (Global Drone Regulations Database, 2017), which has been developed as a multiagency effort provides more in-depth information on drone regulations.

The next agricultural revolution are driven by data, which will help to increase agricultural productivity with minimum damage to the environment and increased livelihoods for communities involved in agriculture.

UAVs application in agriculture opens the gateway to access real time information on the farm. It can be used at different stages throughout the cropping cycle:

- Soil and field analysis – After getting precise 3D maps for soil, planting can be planned and nutrient status can be analysed for further operations.
- Planting – UAS shoot seeds with nutrients in the soil with an average uptake of 75 percent, thus bringing down costs for planting.
- 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.
- Crop monitoring – Time-series animations can show the precise development of a crop and reveal production inefficiencies, enabling better crop management.
- Irrigation – Drones with hyperspectral, multispectral, or thermal sensors can identify which parts of a field are dry or need improvements.
- 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. This information can produce multispectral images that track changes in plants and indicate their health.

In the early days of using drones to capture aerial imagery, just having an aerial image of farmland, added great value. Farmers soon wanted more from their images and the term "actionable intelligence" (Eisaian, 2017) has used. The first step in providing this actionable intelligence was producing crop health maps for farmers to pinpoint areas of potential yield loss. This was achieved by measuring the amount of biomass or live green vegetation in the crops using near-infrared (NIR) sensors that can detect vegetation levels based on the amount of light reflected off the leaves – the higher the biomass content, the more light that is reflected. These vegetation levels use the Normalized Difference Vegetation Index (NDVI), a simple graphical indicator for these measurements, to produce what are called NDVI maps. These maps show crop health through colours, which vary from dark green/blue for areas with most vegetation to red for the least healthy areas.

Now it's all about the sensor attached to the drone, the processing and analysis of that imagery, and the real-time, actionable insights that analysis can give to farmers.

SAP launched Leonardo (FAO and ITU, 2018) which is a digital platform especially tailored to adding insights to data captured from any IoT platform – the very actionable insights that growers and farmers are craving (Fig. 1).

SAP Leonardo innovation portfolio for Internet of things (IoT) solutions integrates technologies and runs them seamlessly in the cloud. It's Design Thinking methodology recognizes the fact that each farmer's and grower's exact requirements are different from a standard software offering, though they may share many of the attributes of prior solutions. For example, data captured from a drone can be incorporated into a system in a standard way that should not have to be rewritten every time an application is deployed, but how the data is analysed and displayed could well change from farmer to farmer. To this end, Design Thinking offers a standard methodology to quickly brainstorm and prototype solid solutions using standard Leonardo software components.

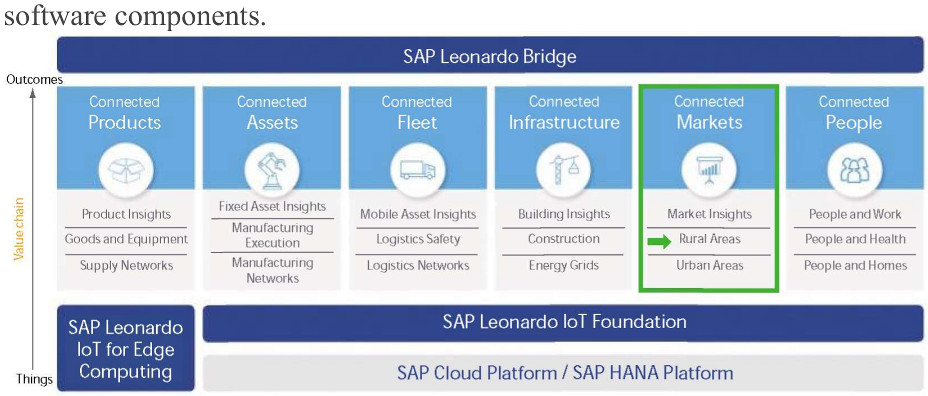

Fig. 1. SAP Leonardo platform structures (FAO and ITU, 2018)

An important design attribute is that the IoT platform uses HANA Cloud. The amount of data that can be collected is staggering, vastly in excess of any cost-efficient traditional on-site storage. For example, a typical drone carrying five sensors complemented by 15 other IoT sensors in the field, with peak sensor data bandwidth of ~50 terabyte/month, sampling at ~1Hz and conducting 10 to 20 field operations per season for a 2 000 ha/farm can produce the equivalent of 50 TB worth of data. Apart from using the cloud to consume and store the data easily, HANA Cloud also has fast analytic capabilities.

Drones in agriculture are aerial camera platform, equipped with an autopilot using GPS and sensors for collecting relevant data. They can be equipped with a regular camera for visible images, which can provide some information about plant growth, coverage and other things. A multispectral sensor expands the utility of the technique and allows farmers to see things that cannot be seen in the visible spectrum, such as moisture content in the soil, plant health, stress levels and fruits. These could help overcome the various limitations that hinder agricultural production.

RESULTS AND DISCUSSION

The agriculture drones market is expected to grow from USD 1.2 billion in 2020 to USD 5.7 billion by 2025 (Markets and Markets, 2020).

Agriculture drones are advanced data-gathering tools for serious professionals. Prices for complete, ready-to-fly ag drone systems range from $1,500 to well over $25,000.

The most challenging part of the agriculture drone surveying process is translating the hundreds of high-res images you just captured into information you can actually use. Most drone operators need to process hundreds of visual, thermal and multi-spectral images per flight, to identify changes in crop health over time or to spot anomalies. All of these images need to be stitched together, converted into orthomosaic 2D images, processed and analysed to get useful information from the flight.

Most agriculture drone operators use the following tools to turn aerial images into useful data. All of them use cloud-based processing:

• Pix4D: this popular & expensive image processing platform converts a series of aerial images into 2D orthomosaics, 3D point clouds and 3D mesh models. Pix4D can also calculate NDVIs, DVIs, SAVIs and custom indices as needed. To use Pix4D, you upload your images, let them process, then receive your reports and visuals typically within minutes to a few hours. Pricing is $350 per month to rent or $8,700 to own.

• AgEagle’s RAPID.

• senseFly’s Postflight Terra 3D: based on Pix4D, this is senseFly’s software for converting aerial imagery into 2D orthomosaics, 3D models and differential indices. Terra 3D is provided free with all eBee drones.

• PrecisionMapper by PrecisionHawk: now called Data Mapper, this is a cloud-based application that gives anyone the ability to upload, store, process, and share their aerial image data. Works with some, but not all, UAS platforms.

• Trimble: designed for professional land surveyors, Trimble's Photogrammetry Module office software to create detailed orthophotos, digital elevation models, point clouds, volume calculations and 3D models. Trimble's general-purpose Inpho UASMaster Module can be used for advanced photogrammetric processing.

• DataMapper by PrecisionHawk: a 100% cloud-based platform that supports image capture, differential processing and algorithmic analysis for many industries. Their unique Algorithm Marketplace lets you pick & apply specific algorithms to extract useful data such as NDVI, DVI, plant counts, scouting reports and more.

• Correlator3D™ by SimActive: advanced photogrammetric processing client software for use on high-end PCs. Several aerial survey firms such as AeroVironment use them. Performs aerial triangulation (AT) and produces dense digital surface models (DSM), digital terrain models (DTM), point clouds, orthomosaics and vectorized 3D models.

CONCLUSIONS

All over the world is a growing concern for the development of intelligent machines for agriculture. This concern has materialized through the emergence of precision agriculture technologies and Digital Farming or Smart Farming concepts, which has transformed into Farming 4.0, the fourth revolution in agriculture. We can conclude that the agricultural industry is about to be disrupted and will transform into a high-tech industry and will need a high skilled farmers.

There are several challenges pertaining to the implementation of UAVs in the agricultural context:

– Right from planning the flight path till processing the final image, software plays a crucial role in the applicability of this technology.

– Different nations have their own regulatory regimes pertaining to the use of UAVs in agriculture.

– Technological unawareness may be a hurdle in its penetration.

– Most drones have short flight ranges thus limiting the acreage that they can cover. The ones with the longer flight ranges are more expensive.

– Drones with features that are suitable for use in agriculture are expensive.

– Mostly farmlands may not have good connectivity, thus either the farmer.

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