

Drones in Precision Irrigation Applications

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Abstract—The paper presents how the drones will be deployed in SWAMP pilots and future precision agriculture. We present our vision of drones as autonomous sensor and communication platforms that execute multi-purpose missions in farms. Drones carrying mobile gateways can provide communication services for very low cost short-range radio equipped sensors. Changing the payload to multi-spectral camera and applying data analytics for images provide accurate information of the vegetative state of the crop. Both mission benefit from the capability to fly autonomously in various conditions in farms.

I. INTRODUCTION

Drones have become extremely popular. Use cases vary from imagining, to challenging inspection applications, and delivery tasks. With this variety of purposes, also the drones have evolved to very different type of devices from long-distance airplanes to in-door helicopters. The control of the drone has evolved at the same time. We have moved from line-of-sight radio control to camera signal based control, to automatic flight controllers, and to autonomous flying. Applying drone into even more challenging tasks has been limited only with regulation, where public safety and privacy have been main concerns, and technical capabilities of drones related to for example drone size, weight, payload, and flight time.

In agriculture domain, the drones have been mainly used for imaging purposes. The payloads have been different types of cameras. Normal cameras have been used for inspection purposes. Multispectral or hyperspectral cameras are used for analysing crop condition in more detail. As hyperspectral cameras are becoming lighter and smaller, their use is expected to increase. Combining the drone technology with IoT, imaging and data analytics give us possibility to examine the status of crop in higher granularity and precision. Creating this multipurpose possibilities of drones can also change the business possibilities. Currently drones are considered as rather expensive and complicated devices that require flying and maintenance expertise. Therefore, the service model has been most common. With several use scenarios, increasing autonomy, data analytics, and linking to for example irrigation system control, the value of drones increase and may enable also other business models.

In this short paper, we present our vision and approach of using drones as autonomous, multi-purpose platform for precision agriculture. We present our imaging approach and

data collection from low-range, low cost sensors. Finally, we will discuss about potential of drone platforms in future.

II. DRONES IN SWAMP APPROACH

The SWAMP project approach applies IoT and data analytics for water distribution and precision irrigation. The main idea is to analyse the water need of plants, and to execute the irrigation based on that and expected weather. As sensors, we have used soil parameter sensors, e.g. moisture, conductivity, and temperature, RedEdge-M multi-spectral camera, and normal weather sensors (Libellium weather station). The data is transmitted to SWAMP cloud where it is stored, analysed, visualised, and used for planning water distribution and irrigation.

The role of drone in the system is naturally to carry multi-spectral camera and to take pictures for the analysis. Another task is to read low-range sensors, to store data into local gateway, and to transmit it to cloud. We call this task a data mule.

III. DATA MULE

In farming applications the cost of sensors and battery lifetime of sensors are essential. Number of sensors can be quite big. Especially if field properties or if water flow inside the soil varies. In bigger farms, the pure number of sensors is a cost issue. Batteries are typically made of harmful materials that cannot enter to harvested crop. The cost of changing batteries is not acceptable. Due to these reasons, we have decided to experiment with Bluetooth low-energy and RFID sensors that have very low-range radios or can operate even without batteries. The problem is then how to transfer data from field to cloud.

The data mule concept consists of drone that carries mobile gateway and RFID reader. The drone flies over the field using pre-planned route and collects the data from sensors. Depending on the sensor type values are sent immediately to cloud or all the values are bundled into single message that is transmitted to cloud after the flight.

IV. IMAGING

Drone is also used for taking multi-spectral images of the crop. The key issues are the stabilisation of the drone precision of manoeuvrability of the drone. Both affect to quality of final picture. The data analytics part of picture consist of stitching taken pictures together to represent the whole field and of

running different analyses functions for detecting various aspects of the crop. So, far we have focused on analysing the growth of crop using normalised difference vegetation index. It shows the differences in crop growth in different areas of the field and thereby reveals different management zones.

V. DISCUSSION

Current proof of concepts presented in this paper only scratch the surface of precision agriculture. However they also show that drones can produce added value even though we have to acknowledge that other solution such as LoRA type of longer range IoT radios are competitive at the moment. Autonomous flying and maintenance free operations that do not need flying expertise will be key issues for future use of drones.

Big issue in agriculture and farming is the need of manual work. Some crops such as lettuce or spinach are small plants and need to plough the field and construct benches and irrigation systems twice or even three times per year. And of

course to do the opposite as well. Everything needs to be removed as well. Therefore, the placing and removing of sensors should be automated. It might even be possible to use disposable sensors, if battery-less radios would be used.

Another significant improvement for precision agriculture would be chemical analyses of plants and soil. Solutions that combine fluids and electronics on single sensing elements are already being researched. Taking soil or plant samples will introduce the need for more advanced drones, when this kind of sensors hit the market.

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