AN OPEN-SOURCE MULTISPECTRAL CAMERA FOR CROP MONITORING #9281

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ABSTRACT

Precision agriculture is one of the most important economic issues of the 21st century because it will make it possible to respond to the new challenges of agriculture, which are population growth, global warming, global epidemics, and inflation, to name a few. Remote sensing makes it possible to monitor the plantation from a distance and makes it possible to know the level of growth and the state of health and hydration of the plants. This paper outlines an affordable and open-source multispectral camera to calculate the biomass of crops. The camera can be fixed in a corner of the field. It can be carried by a mobile robot that moves across the field, it can also be attached to a drone-type flying device to cover more territory and for tree crops. The system is based on a raspberry pi board, an infrared camera to which we add color filters and an RGB camera. The luminance is corrected thanks to a luminescence sensor. We add to this a rechargeable battery for the power supply. The shots are stored on an SD card and can be transferred to a computer. The camera can connect to the internet, and we can observe the field in real time from anywhere on the globe. The raspberry pi board is a nano-computer, we could program it in python. An application has also been developed to read and process the images. Thanks to the latter, we can mosaic the images, extract the indices, and compare with older images. It is also possible to observe cultures in real time by streaming. The application can also deliver displays in the form of graphs, tables, and maps. The tests were carried out on different data sets and on different crops and the results were compared with the values given by agronomists, which turned out to be closely related.

Keywords: Remote sensing, multispectral camera, biomass, raspberry pi, open-source, crop monitoring.

INTRODUCTION

Precision agriculture is a new field, there are currently few farms using this technology, due to the high cost. In the field of agriculture, water management, farming systems and agri-food value chain are key domain [1, 2, 4]. Precision agriculture makes it possible to save water, insecticide, and fertilizer. Remote-management makes it possible to reduce field displacements in the case of arid zones and in these times of COVID-19 [3]. In this work we present a new prototype of crop remote monitoring station that is solar (self-powering), open-source and available for small-scale farms. This station can be settled on fields and provides information about the soil and weather thanks to a set of sensors, and biomass information thanks to a multispectral camera module and a real time camera. We can see in Fig.1 the station schema. In this paper we describe firstly the station, after we present some results and then we finish with a conclusion and outlook.

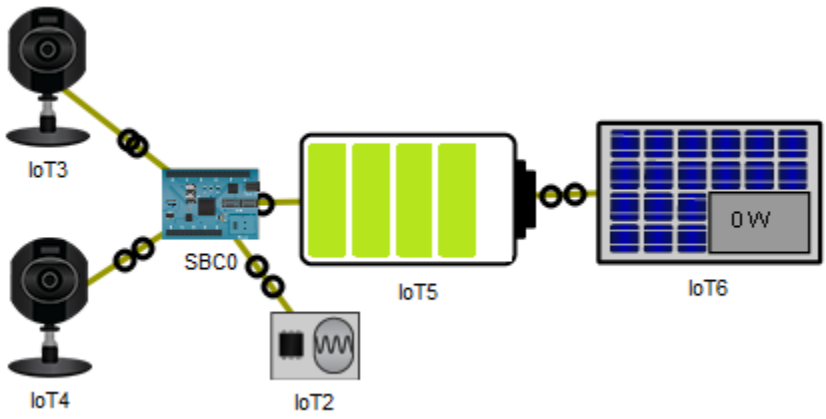


Fig. 1. The camera schema realized with cisco packet tracer software.

MATERIALS AND METHODS

The station is composed of four modules: a power module, a sensors module, a wind sensor module, and a multispectral camera module. The power module is made up of a solar panel, batteries, and a battery charger component. It provides the current to the other modules. The sensors module is made up of a set of sensors: a capacitive soil moisture sensor, a rain sensor, a pressure sensor, fire sensors, a humidity sensor, a light sensor, and a temperature sensor. The multispectral camera module is made up by multiplexing Pi daylight camera and PiNoIR cameras, with the use of color filters to obtain different light spectra. Fig. 2 presents the components of this module.

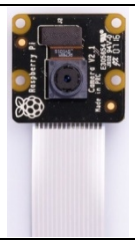
PiNoIR Camera	Pi Camera v1.3	Multiplexer	Camera filters
			
Solar panel	TSL2561 Luminosity Sensor	Raspberry pi 4	
			

Fig. 2. Multispectral camera elements.

The entire sensors are commended by a nano computer (model Rapberry Pi 4). It is this computer which also saves and sends the data to the server every hour of the day.

RESULTS AND DISCUSSION

The station modules can be simply installed in every field or zone on any support; however, the camera module must be installed in a high support to enlarge the view. It can be also set in a drone.

The application provides different kind of display. We can display graphics of the sensors data by hour, day, month, season, and year and by field, zone, or station and naturally by sensor (Fig. 3). We can also display the cameras photos or the real time capture.

Fig. 3. display graphics of the sensors.

Nowadays, the remote crop monitoring is important, among the benefits we can cite: the increase of production and the production quality, the water saving, the accurate field evaluation, the reduction of environmental footprint, the real time monitoring, and the reduction of displacement to prevent exposure to COVID-19. We presented in this paper a new prototype of affordable and open-source sensor solar station connected to the internet for small scale farms. This station provides soil and weather information of the fields. It allows also tracking the crop via real-time images and getting information about biomass via a multispectral camera. This work can be improved by the proposal of an open-source model of agricultural drone for the monitoring and mapping of crops.

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