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Identification of weeds in sugarcane fields through images taken by UAV and Random Forest classifier

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Abstract: Sugarcane is one of the most important cultures in the world. The productivity of sugarcane is affected by many factors, among them weeds can cause several problems. Weed control is made usually by herbicides application because sugarcane occupies extensive areas, and due to the same reason, the decision about herbicide type and dosage has been done by sampling. This work mode does not allow variation and causes problems of herbicide application, since the presence and weed type may not be uniform in whole field. There are some solutions based on satellite image analysis that allow the coverage of the entire field, solving the problem caused by sampling sense, but this solution depends on high weed infestation and a clear sky for good results. This work proposes a system for weed surveying, based on image pattern recognition with pictures taken by a UAV (Unmanned Aerial Vehicle); this alternative can take pictures very close to the plants, which allows species recognition in lower infestation levels and without clouds interference. This solution achieved an overall accuracy of 82 % and kappa coefficient of 0.73 in preliminary tests.

Keywords: weed, pattern recognition, machine learning, images, UAV, sugarcane

1. INTRODUCTION

Sugarcane is one of the most important crops in the world, especially in Brazil, the largest world producer of sugar and the second largest producer of ethanol. The development of this culture depends on several factors such as soil type, light conditions, rainfall, irrigation, fertilization and weed presence (Rodrigues, 1995). The control of this last factor has taken great importance in recent years, because of growth of mechanized harvesting, which is impaired by certain types of weeds, which entangle the machine gears, causing high maintenance costs and also service outage (Azania et al, 2002).

Thus, weed control is very important in sugarcane culture because besides the aforementioned reason, these plants also compete for light, water and soil nutrients, and can produce allelopathic substances that damage the sugarcane (Christoffoleti et al, 2006).

Farmers control weeds with the use of herbicides, because sugarcane plantation occupies large areas. Usually, human sensing determines the herbicide dosage and type, which has a good perception of the presence of invasive species. However, this is done by sampling, which causes problems of herbicide waste and misapplication, since the degree of infestation may vary from one location to another, as well as the species present in the plantation.

In order to avoid herbicide application wasting, there are several researches that perform weed surveying by satellites (Cavalli et al, 2008), but for a good pattern recognition, this method depends on high weed density and suffer from the influence of clouds to take good pictures (Johnson et al, 2012).

An alternative to the use of satellites would be the utilization of Unmanned Aerial Vehicle (UAV) that fly in low altitude, without cloud interference and can take higher resolution pictures. Peña et al. (2013) describes the identification of weeds between the lines of a corn crop, carried out by analysis of images captured by an UAV, using a multispectral camera.

This work proposes a system for weed surveying, based on image pattern recognition with RGB pictures taken by an UAV. RGB cameras have already been used in UAV Systems (Yun et al, 2012) and are affordable to everyone (Fehr, 2016), so this solution can reach a large number of users. Another difference from Peña et al. (2013) is the weed identification performed not only between the lines, but also in any inch of the sugarcane field.

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We chose the Random Forest (RF) classifier to make the weed identification in this research because of its high accuracy and broad use by remote sensing community (Belgiu et al, 2016).

Following this introduction, Section 2 describes the experimental system used in the validation of the proposal investigated over this work; Section 3 deals with the results, and finally Section 4 presents the conclusion of this work, as well as prospects for its continuation.

2. MATERIAL AND METHODS

Previous section described the importance of weed detection in sugarcane fields. This section describes the experimental system used to take pictures and the process of weed identification.

Fig. 1 presents the Weed Identification System (WIS), which has seven steps. The Random Forest Library used by this system at step four is part of Weka, a free Software of University of Waikato, Hamilton, New Zealand. All data processing was done using an Intel Core I5 de 3.4 GHz 8 GB RAM, based on Windows 7.

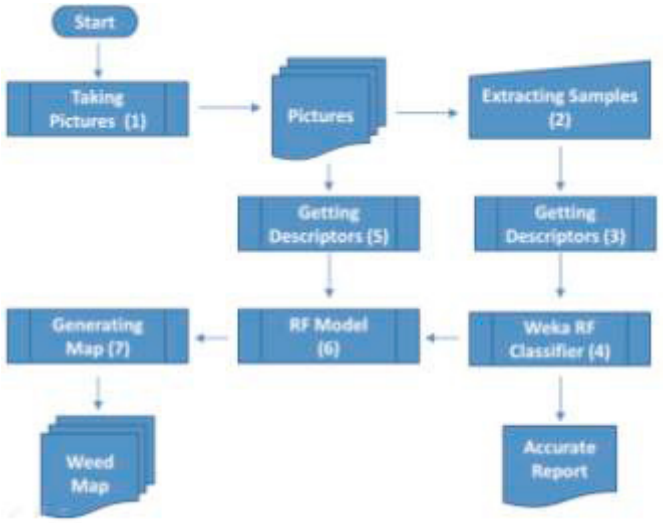

Fig. 1. Weed Identification System flowchart.

2.1 Taking Pictures

The first step of the WIS is the picture acquisition. As previously described, images will be taken by a camera in a UAV. The UAV used is a DJI F450 Quadcopter (Fig. 2a) and the RGB camera is a GoPro Hero3 Silver Edition 10 MP (Fig. 2b).

Fig. 2a. DJI F450 Quadcopter.

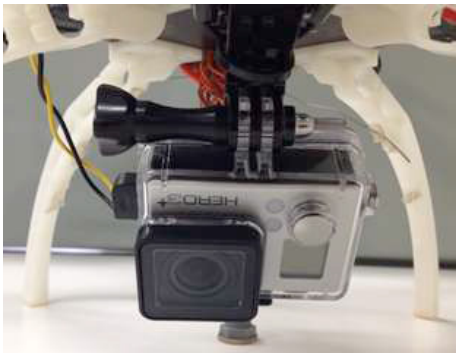

Fig. 2b. GoPro Hero3 Silver Edition.

2.2 Extracting samples

The aim of this work is identify the presence of some weed species in the field, especially the most harmful to the sugarcane. To achieve this objective, a model was designed with these species selected to be identified in supervised machine learning. After the pictures taken (step 1), next step is extracting samples from these pictures to be used in Weka RF Classifier (step 4) for a model creation.

The process of extracting samples from images (step 2) was a manual activity and the identification of the weed samples was performed by specialists (Rahman et al, 2015), because of the great variability of weed species and the difficult to distinguish each of them (Benlloch et al, 1996). In the future a data-base with the most common and harmful weeds will be made to automate the sampling process, this database will consider the weed stage of growth, the image resolution and the history of weed incidence in the crop where the images were taken from.

Fig. 3a is an example of part of a picture taken by a UAV with three main species of plants (sugarcane, narrow leaf weed and large leaf weed) and Fig. 3b is the same part of the picture from which samples were extracted.