Desired Flight Height of a Drone in Plant Species Counting by Means of Digital Image Processing

Altura de vuelo deseada de un dron en conteo de especies vegetales mediante procesamiento digital de imágenes

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Summary. Different daily and research activities in numerous fields have the counting of certain types of objects (vehicles, people, cells, among others) as a main process. Currently and in almost all cases, this counting procedure is performed manually. With the advent of the unmanned flying vehicules, new viable applications for the image and video analysis without limitations for the aerial view cameras are emerging. Determining a suitable algorithm for aerial counting by digital image processing is essential for good counting performance. This work is not focused in the counting algorithms, this work contributes in pinpointing a desired optimal elevation of a drone to run images than the algorithms recognize more accurately.

Keywords: Digital Image Processing, Counting, Drone, Desired Height.

Resumen. Distintas actividades cotidianas y de investigación en numerosos campos tienen como proceso principal el conteo de cierto tipo de objetos (vehículos, personas, células, entre otros). Actualmente y en casi todos los casos, este procedimiento de conteo se realiza de forma manual. Con la llegada de los vehículos voladores no tripulados, están surgiendo nuevas aplicaciones viables para el análisis de imágenes y videos sin limitaciones para las cámaras de visión aérea. Determinar un algoritmo adecuado para el conteo aéreo mediante el procesamiento de imágenes digitales es esencial para un buen desempeño del conteo. Este trabajo no se centra en los algoritmos de conteo, este trabajo contribuye a señalar una elevación óptima deseada de un dron para ejecutar imágenes que los algoritmos reconocen con mayor precisión.

Palabras clave: Procesamiento Digital de Imágenes, Conteo, Drone, Altura Deseada.

1 Introduction

Several methods for automatically counting objects have been proposed in recent decades. Most of these methods are based on digital images containing the objects and provide an estimate as close as possible to the results obtained manually by human experts. We can find a compendium of them in [1] where the techniques used in this research field are listed. The counting of agricultural species by image processing has been approached from different perspectives: from camera equipped robots [2] to counting with extremely expensive hyperspectral cameras and complicated calibration and recognition algorithms [3], to simpler proposals of sensor equipped drones [4] and very elaborate algorithms with high computational load [5] y [6]. In this paper, we willapproach the count problem in plant vegetal species from the perspective of the height of the Drone, because as shown below, at different heights the variation of shades of green to assess the number of objects in a RGB image is difficult to detect with commercial basic cameras sensors.

2 State of the Art

We have not found a similar article that focuses on the height of the drone, they are all focused on the processing algorithms, so it is relevant to help the processing and focus on the optimal height of the drone.

however, we present the Experimental environment.For the definition of the results, we used a DJI Mavic Pro Drone which was equipped with a DJI FC550 HD camera with a CMOS 11 Mpx sensor. 4 different types of crops were used for its green shades and they were located in the region of Cocula, Jalisco, Mexico. The crops are shown in figure 1 and they are geographically located at coordinates 20.3713, North latitude and 103.8097 West longitude for an avocado crop, 20.4192 North latitude and 103.8849 West longitude for a sugarcane crop, 20.4160 North latitude and 103.8841 West longitude of a lemon crop and 20.4163 latitude North and 103.8859 latitude West for sugar cane crop. The four previous crops are at an altitude of 1320 meters above sea level.

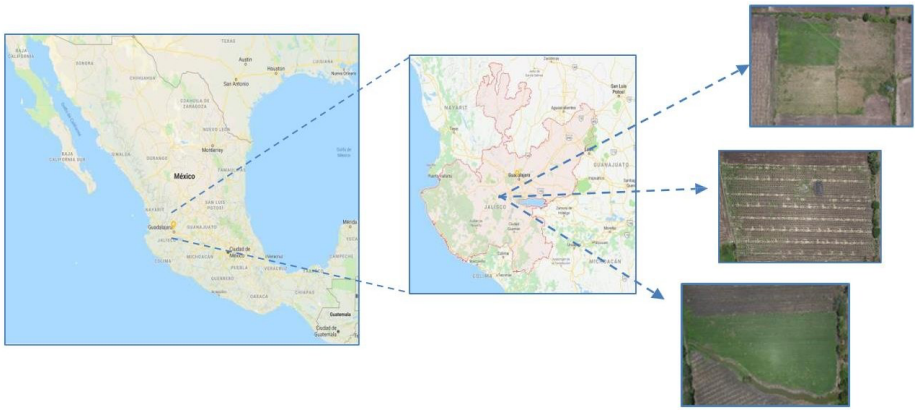

Figure 1. Selected study area

3 Methodology used

The Drone was elevated to an initial height of 1554.3 meters above sea level, ie; 234.3 meters above the surface of the ground and a downward scan was performed, approximately every 20 meters an image was captured for processing. Figure 2 shows the different images captured with the drone camera indicating their corresponding elevation with respect to the ground. The counting was performed by image processing using the labeling algorithm described in (Haralick, 1992) and implemented in Matlab software, being the simplest to implement and therefore not very robust, with little tolerance to noise in the image and low discrimination between similar objects. We chose this algorithm for its response to different image heights with the Drone, its simple implementation. The morphological operations to adapt the image to the label counting algorithm are simple operations of dilation that consists of joining neighboring pixels to the object of study and erosion that consists of eliminating neighboring pixels to the object of study, these two operations in images are called basic morphological operations within digital image processing. Figure 3 shows the morphological preprocessing procedure of the image for lemon crop at 109.5 meters above ground level.

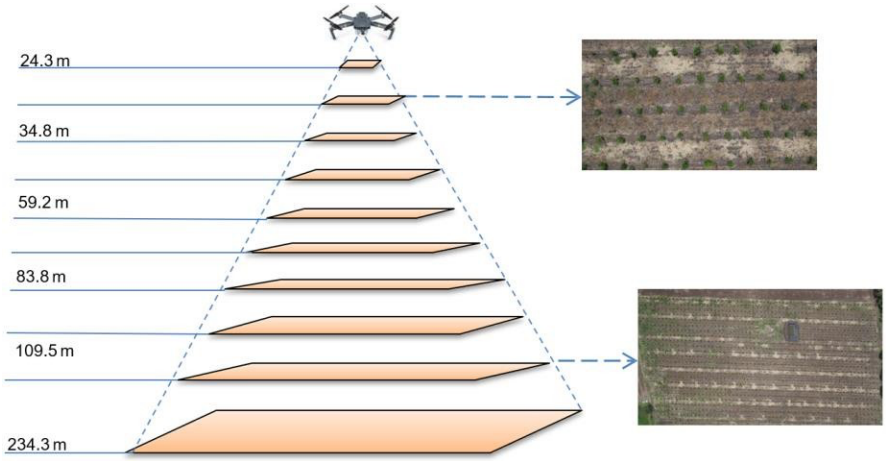

Figure 2. Drone scanning of crops (lemon) at 10 different elevations.

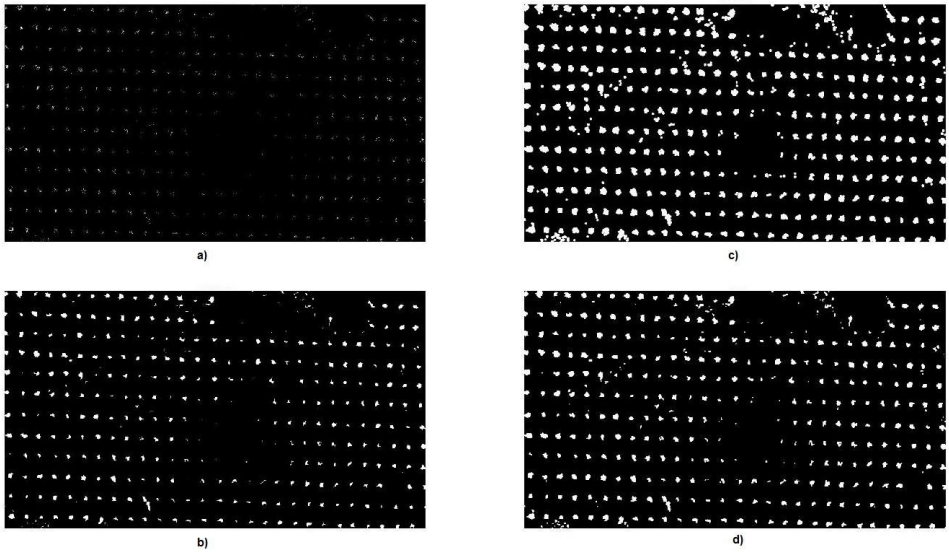

Figure 3. Morphological preprocessing for counting. a) Binary image. b) Dilation of points to eliminate gaps. c) Erosion to eliminate peaks and unwanted points and d) Final dilation to define desired objects.

First the image is acquired, then it is binarized with a suitable threshold to avoid losing bushes, as the result of the binarization some clouds of points remain, we apply the dilation operation to fill these gaps and consolidate everything in a single object, then the image is eroded to filter the points that do not correspond to objects of interest and eliminate them and finally a final dilation is done to emphasize the objects of interest and proceed to labeling for counting.

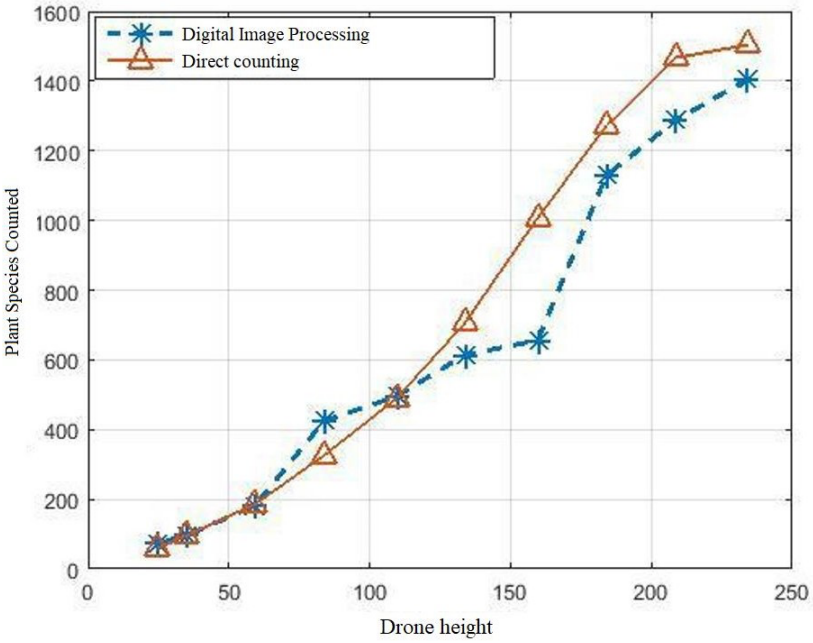

Figure 4. Direct count and count by digital image processing for different heights of the drone.

4 Experimental Results

The digital image processing was performed and the counting algorithm was executed by means of labels with the same parameters for the pre-processing described in the previous section. In Figure 4, the red line with triangular marker shows the direct counting of plant species (in this case lemon bushes) carried out in the traditional way, that is, by a human expert walking through the crop and counting plant by plant. The blue line with asterisk marker shows the count for the same area but with the counting algorithm. We can observe that as the height of the Drone increases, the counting by digital image processing gives more inaccurate results, but covers a larger area, the height where the best results were obtained is the height from 20 meters to 60 meters, where the counting by means of the Drone and the algorithm is equal to the manual counting. On the other hand, Figure 5 shows, according to each of the 10 proposed heights, how the counting error decreased, i.e., the higher the height, the greater the error.

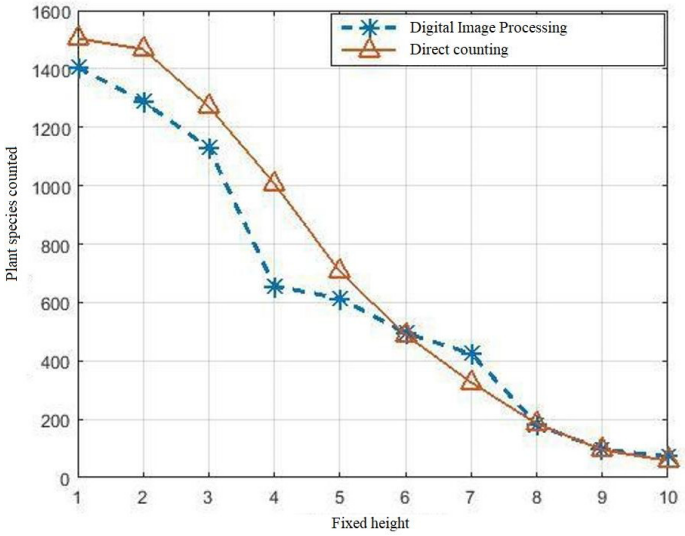

Figure 5. Decrease in counting error by digital image processing.

5 Conclusions and Directions for Future Research

We present the count of plant species in a height sweep to determine the desired height of the drone when capturing images and submitting them to digital processing algorithms. The results obtained and presented in Figures 4 and 5, are clearly inclinedto take images at heights less than 60 meters. We performed a basic count with the same parameters for all images for easy implementation for comparison purposes. The higher the height of the Drone, the more difficult it is for the algorithm to identify different types of green or discrimination between the objects of interest, at heights of 100 meters and above, depending on the density is where we get good counting results, however it is necessary to go over the area with more images to cover all the ground, because the lower the height the less surface covered by each pixel in an image.

In the future we intend to expand this work to different heights and more algorithms to compare height vs. algorithm and verify the ideal results for each proposed algorithm. At the moment for counting by digital image processing and the labeling counting algorithm, the desired height is between 20 and 60 meters.

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Referencias

[1] Garcia A. B. A Review on Methods for Automatic Counting of Objects in Digital Images, in IEEE Latin America Transactions, vol. 10, no. 5, pp. 2112-2124, 2022.
[2] Ying A. L. et al. Efficient counting and localizing objects of interest for agricultural automation, TENCON Penang, pp. 3063-3067. 2017.
[3] Singh K. D. Advanced calibration to improve robustness of drone-acquired hyperspectral remote sensing data, 6th International Conference on Agro-Geoinformatics, Fairfax, VA, pp. 1-6. 2017.
[4] Saha A. K. et al. IOT-based drone for improvement of crop quality in agricultural field, IEEE8th Annual Computing and Communication Workshop and Conference (CCWC), Las Vegas,NV, pp. 612-615. 2018.
[5] Hsieh M. R. et al. Drone-Based Object Counting by Spatially Regularized Regional Proposal Network. IEEE International Conference on Computer Vision (ICCV), Venice, pp. 4165- 4173. 2017.
[6] Jianjun Ni et al. Automatic detection and counting of circular shaped overlapped objects using circular hough transform and contour detection. Intelligent Control and Automation 12th World Congress on, pp. 2902-2906, 2016.
[7] Haralick, Robert M. (1992). Computer and Robot Vision. Volume I, Addison-Wesley, pp. 28-48.