Segmentation of the area covered by acorn trees in the Spanish dehesa of Extremadura

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Abstract

Acorns are the fruit of oak trees and are an important crop in the Spanish dehesa of Extremadura because of the value they add to the Iberian pig's diet in order to obtain the "acorn" certification. Because of this, it is desired to maximize the production of Iberian pigs with the appropriate weight. On the other hand, to know the area covered by the acorn tree crowns to determine the Trees Covered Area (TCA), a value necessary to estimate the number of Iberian pigs that can be released per hectare, as regulated by Royal Decree 4/2014, issued by Spain in January 2014. This paper proposes a method to automatically estimate the AAR through digital aerial images (orthophotos) of the dehesa of Extremadura and, with this, facilitate the determination of the number of Iberian pigs that can be released on a specific parcel of land. The requirements for automatic detection include the correct identification of acorn trees, correctly discriminating their shadows and of young acorn trees that are still unproductive or shrubs that are not oaks. These requirements represent challenges that apply to both automated and manual segmentations. The automated segmentation in this study is based on the k-means version of the clustering algorithm. The results of this work are promising when compared to real images and when compared to the results of manual segmentation.

Introduction

The automation of digital crop image analysis is a very active field of research where the disciplines of computer vision and agromotics converge (Cubero, 2011) and can be applied to the identification of acorns in digital images. Identifying acorn tree canopies in a natural setting is a difficult task. First, it is important that acorn trees are correctly identified, which can be done by their size, shape, color, or texture. Second, the edge of the tree canopies are set against images of ground and shadows. Some examples are given in the image where correct identification of acorn trees is a challenge. Fig. 1 gives some examples where correct identification of acorn trees is challenging. These include when a tree's shade is cast on itself or cast on the ground where the canopy and shadows have similar colors or when a tree canopy has several regions, such as when the tree is near shrubs or hollows. In this study, we establish a boundary between tree canopy and ground and shadows by using a segmentation method. The segmentation process consists of dividing an image and isolating the regions of interest, which are acorns in this study. The segmentation method is based on the homogeneity of the features describing the different regions of the images that were obtained for the purpose of identifying geographic features in plots of land used by farmers and ranchers.

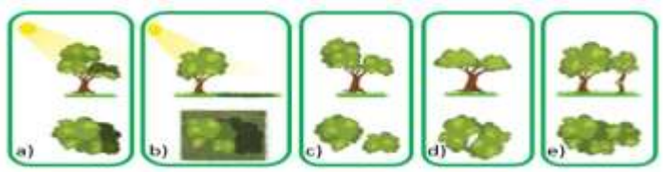

Figure 1 Challenging cases for the detection of acorn tree crown areas. a) Tree casting its shadow on itself, b) Tree and area in the same zone, c) Tree with isolated crowns, d) Tree crowns with holes, e) Set of trees.

Materials and methods

Proposed model.

The proposed model used for the project "Segmentation of the area covered by acorn trees in the Spanish dehesa of Extremadura" is shown with a block diagram that presents each of the stages that will be carried out in the development of this work.

Study área

The study images correspond to a holm oak pasture in the town of Alconchel, in the province of Badajoz, Spain, located at the following geographical coordinates: latitude 38° 35' N, longitude 7° 14' W, and an altitude of approximately 180 m above sea level. This area is very close to the Guadiana River, which represents the border between Spain and Portugal. The aerial images were provided by the National Geographic Institute, which belongs to the Ministry of Public Works, from a flight conducted in 2011. These images have a resolution of 0.25 m/pixel and are provided in JPEG format. For this work, the 38 aerial images (Im_58 to Im_95) in three color bands (RGB) are consecutive in horizontal direction. Therefore, each image represents a dimension of 64 m x 64 m, or an area of 4096m^2 , and the total surface of the 38 images corresponds to 64 m x 2432 m which represents an approximate area of 15.56 hectares.

Figure 2 Dehesa of oak trees in the town of Alconchel, in the province of Badajoz, Spain.

Figure 3 Geographical location of the study area latitude 38° 35' N, longitude 7° 14' W.

Color space conversion

Color space conversion is the translation of the representation of a color from one base to another. This usually occurs in the context of converting an image represented in one color space to another color space, aiming to make the converted image as close as possible to the original. The color space change is being applied because it is easier to segment an image in L*a*b color in order to find more precise objects or edges of interest.

Figure 4 RGB color image

Figure 5 CIE L*A*B* color image

Automatic image segmentation.

This is the main phase, where the method under study in this work is applied: the k-means clustering algorithm proposed in (MacQueen, 1967). Taking as a starting point the data structure achieved in the initialization and a number k of groups. The algorithm performs the k-means steps:

1. **Initialization**: the location of the centroids of the K groups is chosen randomly.
2. **Assignment**: each data is assigned to the nearest centroid.
3. **Update**: the centroid position is updated to the arithmetic mean of the data positions assigned to the group.

Steps 2 and 3 are iteratively followed until there are no more changes.

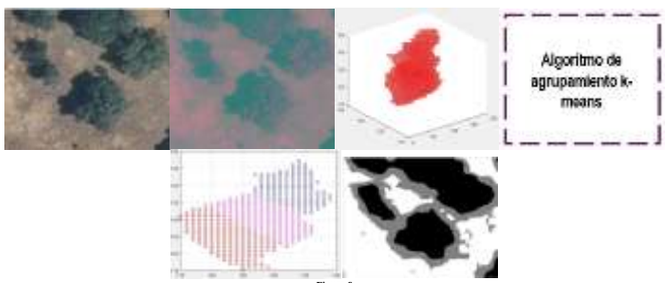

Figure 6

Results

The initial number of groups to identify was three, due to the desire to obtain trees, shadows and soil. But because the trees and shrubs have very similar characteristics (except for size), they were identified in one group, another to shadows and one more corresponded to soil. When both groups were not well identified, the number of groups was increased by one at a time until good results were obtained. This situation occurred when there were few acorn trees in an image and most of the image was ground. It was not necessary to increase the number of groups beyond a value of three because the trees in the images were correctly identified.

Figure 7 Original image

Figure 8 Manual segmentation

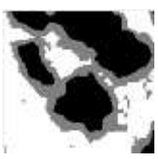

Figure 9 Segmentation by k-means

Figure 10 Automatic detection of acorn trees and shrubs

Conclusions

Due to the importance of correctly estimating the AAR to the "acorn" certification for swine in Spain, an automatic approach was proposed for the estimation of this value using aerial images, which yielded a value of 33.90%, higher than the corresponding value of 30.85% calculated using a manual approach. The advantages of this proposal are that the crown areas of acorn trees were segmented more consistently in all images and were closer to the real images, because the total area of shadows was integrated in the calculation and a global correction factor is feasible to correct this effect.

It is concluded that in order to obtain favorable results in the segmentation process there must be a good shadow removal process and thus be able to obtain more easily the whole area within our study area. The procedure proposed in this work could be of great relevance to certified beef producers, and if an estimation of the shadow areas in the automatic segmentation could be eliminated, then the method could play a crucial role in realizing a more accurate operation estimation of the AAR. A consequence of adopting this method would be the estimation of a maximum stocking rate that optimizes the use of resources as well as the production of high quality meat. A shadow correction factor could be calculated and applied in future studies.

Future of research

The project "Segmentation of the area covered by acorn trees in the Spanish Extremadura dehesa" has a lot of work to do in the future since the segmentation of the tree crowns is a very big challenge, it can be deduced that more experiments with different clustering algorithms should be carried out to have different comparisons and thus be able to conclude which technique is closer or closer to the digital images that are being worked on.

It remains to be emphasized that if this project is further developed in the future it will be of much help to people who sell certified meat in Spain, since it will help them to evaluate and visualize the percentage of Iberian pigs in green areas within a large number of hectares.

- It is proposed to test other segmentation techniques in order to make comparisons.
- Propose an automatic classification of the areas once they are segmented based on an Artificial Neural Network.

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References

Bezdek, J. (2017). A Primer On cluster Analysis: 4 Basic Methods That (usually) Work. Desing Publishing

Cubero, S. A.-S. (2011). Advances in machine vision applications for automatic inspection and quality evaluation of fruits and vegetables. Food Bioprocess Technol. 4, 487-504.

Jain, A. &. (1988). Algorithms for Clustering Data. Prentice Hall, New Jersey.

Jain, A. (2010). Obtenido de Data clustering: 50 years beyond K-Means. Pattern Recognition Letters, 31, 651-666.

MacQueen, J. (1967). Some methods for classification and analysis of multivariate observations. Fifth Berkeley Sysmposium on Mathematical Statistics and Probability, 1, 281-297.

MAPA. (2007). Real decreto1469/2007, de 2 de noviembre, por el que se aprueba la normade calidad para la carne, el jamón, la paleta y la caña de lomo ibéricos. Boletín del Estado 264, 45087 - 45104.

MAPA. (2014). Real decreto 1469/2007, de 10 de enero, por el que aprueba la norma de calidad para la carne, el jamón, la paleta y la caña de lomo ibérico. Boletín del Estado 11, 1569 - 1585.

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