EXTRACTION OF GREENHOUSE AREAS WITH IMAGE PROCESSING METHODS IN KARABUK PROVINCE

M. Z. Yildirim [a, *], C. Ozcan [a]

[a] Karabuk University, Dept. of Computer Engineering, 78050, Karabuk, Turkey - (m.zahidyildirim, canerozcan)@karabuk.edu.tr

KEY WORDS: Greenhouse, Extraction, Image Processing, Remote Sensing, Landsat, Google Earth

ABSTRACT:

Greenhouses provide the environmental conditions to be controlled and regulated as desired while allowing agricultural products to be produced without being affected by external environmental conditions. High quality and a wide variety of agricultural products can be produced throughout the year. In addition, mapping and detection of these areas has great importance in terms of factors such as yield analysis, natural resource management and environmental impact. Various remote sensing techniques are currently available for extraction of greenhouse areas. These techniques are based on the automatic detection and interpretation of objects on remotely sensed images. In this study, greenhouse areas were determined from optical images obtained from Landsat. The study was carried out in the greenhouse areas in Karabuk province. The obtained results are presented with figures and tables.

1. INTRODUCTION

Greenhouse cultivation in Turkey started in Antalya in 1940. After 1960, the use of plastic coverings in greenhouse areas led to a significant increase in the proportion of greenhouse areas. Today, Turkey is among the top four countries in terms of greenhouse assets in Europe. The average annual growth rate of greenhouse in Turkey is around 15% (Coslu, 2016). Analysis of existing greenhouse areas is crucial in terms of raising the quality of greenhouse areas, rural planning, sustainability of production and determination of environmental factors. For this purpose, various studies related to greenhouse detections and classifications have been done.

Greenhouse regions were detected by using basic image processing methods on color images with a spatial resolution of 0.5 meters (Matsuoka, 2012). Plastic and glass-covered greenhouses were detected (Koc-San, 2013). In this study, supervised classification techniques were applied on images taken from WordView-2 satellite in a selected region in Muratpasa province of Antalya province. Maximum likelihood (ML), Random Forest (RF) and Support Vector Machine (SVM) methods have been analyzed comparatively. Object-based classification of stereo images from GeoEye-1 and WorldView-2 satellites has been performed (Aguilar, 2014). They obtained feature vectors from the images and applied the Nearest Neighbor and SVM methods comparatively.

Greenhouse areas have been tried to be detected with unsupervised learning methods by using the spectral and textural properties of WorldView-2 images (Tasdemir, 2014). A fast method is proposed with limited information based on the unique properties of WorldView-2 images (Pala, 2016). They obtained similar results to the supervised classification methods using the Otsu thresholding, contrast values and NDVI features of the selected images. Object-based classification approach is used on the greenhouse images in Altinova region of Antalya province to determine the greenhouses (Coslu, 2016). In this study, multi-channel images of WorldView-2 satellite are also used. Plastics and glass-covered greenhouses have identified on images taken from WorldView-2 satellites in the Kumluca region of Antalya province (Koc-San, 2016). ML, RF and SVM methods have been analyzed comparatively and greenhouse areas are delineated using Canny edge detection method.

In this study, greenhouse areas were determined from optical images obtained from Landsat satellite. Basic image processing methods have been applied to extract and delineate greenhouses. The obtained results are presented with figures and tables.

2. METHOD

In the developed application, images of Landsat satellites taken from Google Earth were used. All images were taken from the greenhouse areas around Karabuk province. Basic image processing methods are applied on the images. The first step in processing imagery is to convert the image to gray. The following steps were applied after the gray image was obtained.

1.1. Thresholding

The threshold is the binary representation (black-white) of the grayscale image. This method is used to separate certain objects from the background on the images and to increase the processing speed. In our work, the Otsu method was used to determine the threshold. This method is based on finding the optimum threshold value by calculating the variance values separately for the background and foreground objects of the image (Otsu, 1979). The variance values for the Otsu method are calculated by the following formula:

$$\sigma^2 = \sum_{i=1}^{n} (x_i - \bar{x}_i)^2 Pr(x_i) \quad (1)$$

where $\bar{x}_i$ is the weighted average and $Pr(x_i)$ is the probability function.

1.2. Morphological Opening

The morphological opening process consists of the combination of erosion and dilation processes, respectively. Objects close to each other on the image are separated from each other by the opening process without degradation (Gonzalez, 1992). The equation of the method is:

$$A \circ B = (A \ominus B) \oplus B \quad (2)$$

where $\ominus$ is a erosion operation to remove image components and $\oplus$ is a dilation operation to enlarge the boundaries of regions. With A and B as sets in Z^2, the erosion and dilation of A by B, denoted are defined as:

$$A \ominus B = \{z|(B)_z \subseteq A\} \quad (3)$$

$$A \oplus B = \left\{z\middle|\left[(\hat{B})_z \cap A\right] \subseteq A\right\} \quad (4)$$

The set of all points z such that B, translated by z, is contained by A and the set of all displacements z, the translated $\hat{B}$ and A overlap by at least one element.

1.3. Object Reduction

After the thresholding and morphological opening, small objects and dots on the image have been removed. Here, an algorithm based on pixel neighborhoods is used. Objects that consist of pixels, which are related to each other under the specified number, have been removed from the image.

1.4. Smoothing Operation

In our application, Gaussian filtering is used to soften the edge regions of objects on binary form images. Gaussian filter is a type of image-blurring filter which uses a Gaussian function to calculate the transformation to apply to each pixel in the image. The equation of a Gaussian function in two dimensions is:

$$G(x,y) = \frac{1}{2\pi\sigma^2} e^{-\frac{x^2+y^2}{2\sigma^2}} \quad (5)$$

Gaussian method is based mainly on the distortion of pixels with a kernel matrix. The size of the used core matrix is selected as 7x7.

1.5. Edge Detection

Edge detection is one of the operations with basic presets in image processing. Determining the edges of the image is useful in many cases. There is a direct relationship between the physical properties of the objects and their edges. Therefore, many physical features of the image can be extracted from the edge information. In this study, In order to determine the edges, Canny edge detection algorithm as well as the Moore-Neighbor tracing method modified by Jacob's stopping criterion were used.

3. EXPERIMENTAL RESULTS AND ANALYSIS

In this study, the success of basic image processing methods in the detection of greenhouse areas through satellite images has been examined. Satellite images are images of Landsat satellites obtained through Google Earth with higher-quality. A total of 9 different images of 221 greenhouses were examined from the sera regions in Karabuk province. The results obtained on sample images of different regions are shown in Figures 1, 2 and 3.

The greenhouse images in the region have been extracted quite successfully by applying image processing techniques. Table 1 contains numerical information for different image taken form this province.

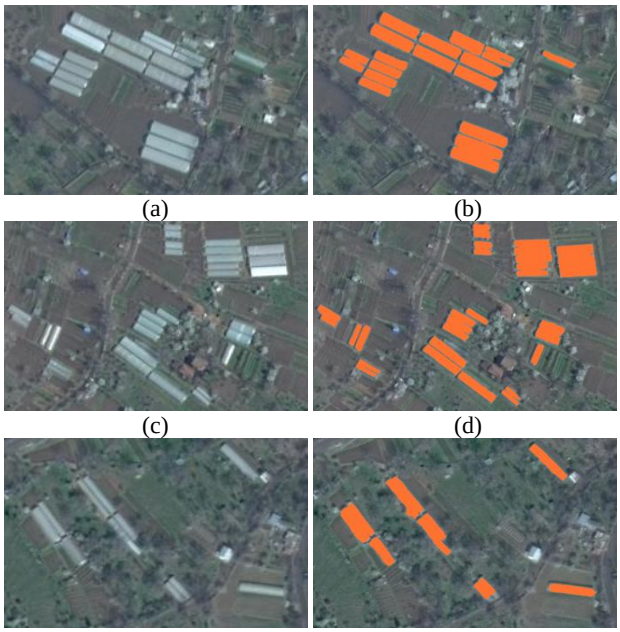

Figure 1. Extraction of greenhouses for three different regions. (a) (c) (e) Input image, (b) (d) (e) Output extracted image

Depending on features such as the background of the images and the brightness of the objects, the greenhouses in the images have been tried to be extracted. In the total of the images, 210 greenhouses from 221 greenhouses that existed were detected. Six false positives were made from objects outside the greenhouse. When all images were determined, 95% success rate was achieved.

Image id	# of greenhouses	# of detected greenhouses	# of incorrect estimation
1	16	15	1
2	20	20	0
3	45	43	1
4	30	30	0
5	29	27	1
6	38	35	0
7	11	11	0
8	15	15	0
9	17	17	1

Table 1. Numerical information for different images

4. CONCLUSIONS

In this study, greenhouse areas were determined from optical images obtained from Landsat. The study was carried out in the greenhouse areas in Karabuk province. In future studies, image processing methods can be supported by well-known supervised and unsupervised classification algorithms to make more efficient estimation with hybrid approaches. In addition, parallel programming can be used to speed up implementation process.

REFERENCES

Aguilar, M. A., Bianconi, F., Aguilar, F. J., and I Fernández, I, 2014. Object-based greenhouse classification from GeoEye-1 and WorldView-2 stereo imagery. *Remote sensing*,6 (5): 3554-3582.

Coslu, M., Sonmez, N. K., and Koc-San, D., 2016. Object-Based Greenhouse Classification From High Resolution Satellite Imagery: A Case Study Antalya-Turkey. In: *International Archives of the Photogrammetry, Remote Sensing & Spatial Information Sciences*, Prague, Czech Republic,Vol. XLI-B7, pp. 183-187.

Gonzalez, R. and Woods, R., 1992. Digital Image Processing, *Addison-Wesley Publishing Company*, pp 524, 552.

Koc-San, D., 2013. Evaluation of different classification techniques for the detection of glass and plastic greenhouses from WorldView-2 satellite imagery. *Journal of Applied Remote Sensing*, 7(1), 073553-1.

Koc-San, D., and Sonmez, N. K., 2016. Plastic and glass greenhouses detection and delineation from worldview-2 satellite imagery. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, 7, pp. 257-262.

Matsuoka, M., 2012. Extraction of Agricultural Greenhouse From High-Resolution Remote Sensing Imagery. In: *The 33rd Asian Conference on Remote Sensing*.

Otsu, N., 1979. A Threshold Selection Method from Gray-Level Histograms, *IEEE Transactions on Systems, Man, and Cybernetics*, 9(1), pp. 62-66.

Pala, E. and Tasdemir, K., 2016. Fast extraction of plastic greenhouses using Worldview-2 images. *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International*, pp. 6292-6295.

Tasdemir, K. and Koc-San, D., 2014. Unsupervised extraction of greenhouses using worldview-2 images. *Geoscience and Remote Sensing Symposium (IGARSS), IEEE International*, pp. 4914-4917.