AN APPROACH FOR SEMI-AUTOMATIC EXTRACTION OF FEATURES FROM AERIAL PHOTOGRAPHS

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ABSTRACT:

Aerial photographs have been evaluated manually by the operators for the extraction of the vector data to produce photogrammetric maps. In the recent years the developments, in the photogrammetry, provides to perform these extraction processes automatically.

In this study, a new semi-automatic feature extraction approach, based on the segmentation of the images using color-differences of the pixels and the propogation of fronts by the Level Set algorithms, is developed. An object-oriented application software is also developed to test the capabilities of the developed method. Some semi-automatic feature extraction applications are made by the help of the developed software using 1:4000 and 1:35000 scale black/white aerial photographs for determining the capabilities of this method.

The results of the tests show that this method can be used for the extraction of some features from aerial photographs for GIS and the production of the photogrammetric maps.

1. INTRODUCTION

Vector data which is needed to produce photogrammetric map is being digitized manually by operators from aerial photographs. These processes can be done automatically by the help of the developments in photogrammetry in recent years.

One of the methods for automatic and semi-automatic feature extraction and classification is image segmentation. Image segmentation is often used method on feature extraction and interpretation from medical images. (Adalsteinsson and Sethian, 1995). Level Set and Fast Marching methods are successfully used in recent years to provide surfaces to develop and propagate on the image taken by classification (Malladi vd., 1994).

In this paper; a new approach based on using image segmentation and level set algorithms together to extract some features semi-automatically from digital aerial photographs and software for testing the approach is introduced.

2. SEMI – AUTOMATIC FEATURE EXTRACTION APPROACH AND DEVELOPED SOFTWARE

The approach that has been developed for semi-automatic feature extraction has been based on level set and image segmentation algorithms. According to this method, three problems had to be solved. The first one was how the algorithm would be started. This problem was solved by marking any point (pixel) on the feature wanted to be digitized by the operator. Thus, level set algorithm would start to work from the point that operator chooses. This solution brought out the approach to be semi-automatic.

Second problem was which criteria would be taken in whether the digitizing feature process would progress or not. This problem was solved by making use of color values of each pixel. The color value of marked point or determined neighborhood level, color values of neighboring pixels and computed color value by getting average, is compared with color value of neighboring pixels and if the color difference is within the tolerance value determined before, algorithm is continued otherwise it is stopped. In other words, segmentation is carried out according to color differences.

After completing the determination of the feature wanted to be digitized and marking process it is needed to get the feature as vector data. Thus the data can be used in a Geographic Information System (GIS). This was the third problem. Raster to vector transformation was carried out to solve the problem. Semi-automatic digitizing approach that solves those three problems mentioned above was configured in five main steps as the integrity of processes. This process steps are:

- The selection of starting point or pixel of the feature wanted to be digitized by the operator.
- Performing the image segmentation of the selected pixel by making use of color difference with neighboring pixels.
- Propagation of the segmentation by using the level set method and storing as a heap sort.
- Getting 1 bit (1 color) masked image from those structured pixels.
- Getting features' vector data in a known format after raster to vector conversion from masked image.

First four process steps were compiled using Borland C++ programming language and using no library files except for system libraries. Fifth step was carried out by the help of a raster to vector conversion open code that is shared in the internet. This code was developed and compiled by using Visual C++ programming language. Some functions like weed tolerance and coordinated transformation tools were added to this code.

2.1 Image Segmentation Algorithm

Image segmentation has been based on color difference and this algorithm had been made flexible by adding a tolerance value that could be set by operator. Thus operator can detect and digitize large areas at one click of the mouse by giving high tolerance value in high contrasted images. Segmentation algorithm threshold value was determined as two times of multiplied value of image width and length.

Segmentation is started from the selected feature point. Value of neighboring pixels and their average value are computed as the reference, according to pixel value and/or neighboring level of the feature point. If neighboring value is zero, pixel's color value is taken on the reference neighboring level is one, color value computed by averaging with the eight pixels around it is taken as the reference value (Eker 2006).

Here, color differences of the pixels in three bands (red, green, blue) are computed one by one and searched whether each is under the threshold or not.

2.2 Storing and Propagating With Level Set Algorithm

Starting value needed for propagation with level set or going along with the feature is coped with by means of the semi-automatic nature of developed method. Propagation of the surface would start from the pixel which is selected by the operator and zero level set would be defined by the location of starting pixel.

Another component that is needed for level set algorithm is the limit value providing the control of propagation. Solution for the limit was carried out by computing the color differences as mentioned above.

Latter there had been one problem to carry out that was which neighboring pixel would be chosen to continue fitting the limit value. As a matter of fact in this solution of the problem Fast Marching method may be used. The function would go on to propagate hence the pixel that has the least value (Sethian, 1998). However, what would the least value be?

In the developed method for the question of what would the least value represent to, the first pixel selected by the operator is admitted as zero level set function and each neighboring pixel (the first pixels in east, west, north, south direction) is checked by the color difference value algorithm mentioned above and the distance from the zero level set (first selected pixel) is computed for the pixels fit the condition, thus diffusing is carried on hence the pixel having the least distance.

Completing the propagation updating process should be carried out (Sethian, 1998). For updating process quadratic equations were used required for computing the difference (Sethian, 1998).

Minimum heap sort had been used in order to store and access the pixels. In the structure of minimum heap sort, the image cell having the least distance from level 0 would be at the top. Certain structure is required for preserving the heap sort. Adding the image cell to the heap, fixing the image cell in the heap, being removed the image cell having the least distance from the heap and updating the structure on the event of every new image cell is added is required.

By means of this storing structure, effectiveness has been increased in large volume processes such as attaining to the image cells, testing and computing the propagation, marking the image cells and storing the marked image cells (Eker, 2006).

2.3 RASTER TO VECTOR CONVERSION

Raster to vector conversion is valid for 1 bit image files which include two types of data (0 or 1), (ESRI, 1997). By the help of the developed software, extracted pixels from the image are marked as colored and the others are black. This new image is saved as a masked image in bmp format.
Open Visual C++ code shared in the internet, was developed and compiled with adding additional functions to convert the acquired mask image file to vector data. The center and the border lines of the features are being converted from raster data to vector data by the help of an interactive interface by setting the connection with the main interface. A coordinated vector data is gained by entering the lower left corner coordinates and image resolution in both two dimensions (x, y) on the main interface. Besides, entering the weed tolerance with an interactive interface, it is possible to get vector data in desired smoothness (Eker, 2006).

If weed tolerance is 0 all the pixels are included in calculation without making smoothness. When the weed tolerance is increased, pixels with increasing intervals are taken into consideration instead of all pixels and vector data becomes smooth. However, it is probable the geometry of vector data may get worse if higher weed tolerance is given (Eker, 2006).

3. TEST STUDIES

Test studies were carried out with the program developed in two groups in order to determine the usefulness and effectiveness of this new approach exposed.

In the first group test study a 1:4000 scaled black/white digital

Figure 1. Applications realized with a 1:4000 scaled aerial photograph.

aerial photograph was used. Thus it was investigated whether the software would be used or not to extract some features in large scaled mapping.

In the second group study by using a 1:35.000 scaled photograph the same investigation was made for middle scaled mapping process.

3.1. Test 1

In the first test work that a 1:4000 scaled white/black aerial photos used which was scanned at 20 microns, roads and buildings were selected as the features that were as semi-automatically extracted from the image. It is shown in the Figure 1 that vector data which were obtained from the result of feature extraction studies that were done related to these selected features. Roads were vectorized from their center and edge lines. Except the obstacles as trees etc., the roads and buildings also the smallest secondary roads could be extracted clearly. Cuts which caused by the obstacles couldn't be solved by this algorithm and these cuts have to be corrected manually by the operator.

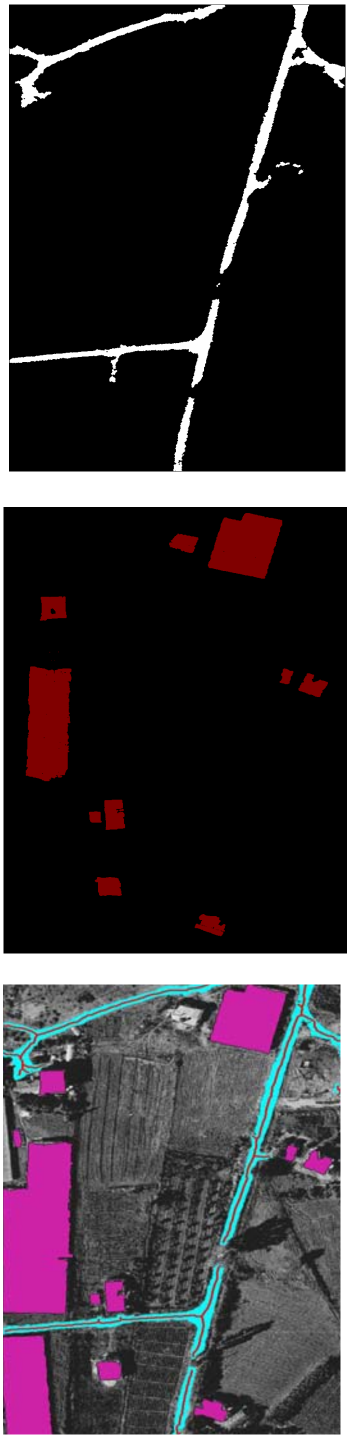

Figure 1. Applications realized with a 1:4000 scaled aerial photograph.

3.1.Test 2

In this test work; three different features were tried to be extracted semi-automatically from a 1:35000 scaled, black/white aerial photo which was scanned at 20 microns. These features are a road with asphalt cover on surface, a wide watery stream and a footpath. Both asphalt road and watery stream were vectorized from their borders as polygons, but footpath was vectorized from center line as a line feature (Figure 2). A few click with the mouse on the road and the stream were enough to extract these features but on the footpath it was difficult. The color difference of the footpath from the texture of the area was not too much, so the propagation was carried out by little steps with small color difference tolerances.

In this work, it is determined that the effects of the obstacles which cover the linear features (tree, car...etc.) become lesser with shrink of the little scale. Because of reduces in scale also the area which involved the pixel numbers that take part of these obstacles reduces. Thus blank quantities that cause by the obstacles take more little values.

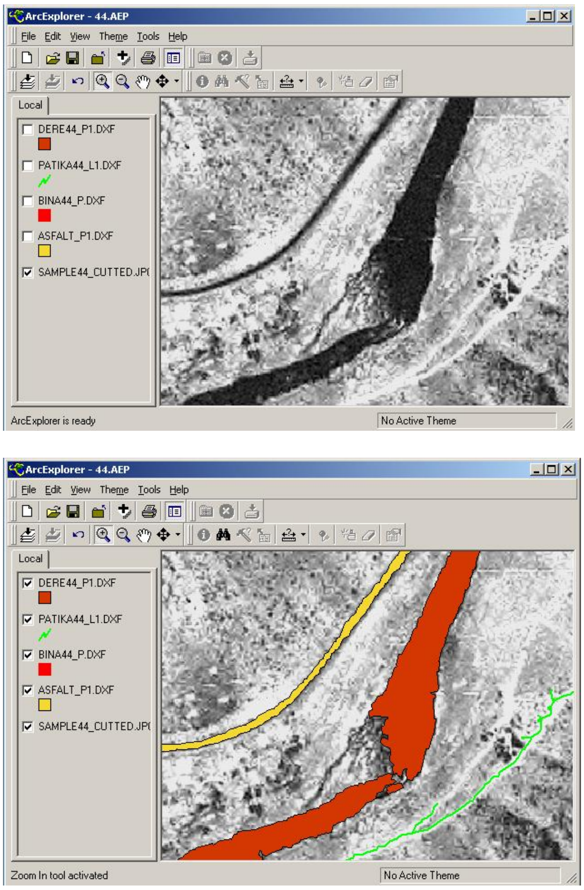

Figure 2. Applications realized with a 1:35000 scaled aerial photograph.

4. CONCLUSION

As the results; with condition of developing of the lacking aspects that are arrange in order below, this approach will be considered as useful on semi-automatic extraction of some features from image for GIS and producing photogrammetric maps from the aerial photos:

- Especially, the obstacles on the features in large scaled images negatively affect the feature extraction process.
- When the tolerance value is not properly adjusted wrong feature extractions may be occurred.
- When very large sized image files used, because of the values of pixels recorded into computer memory in this

approach, some hardware errors may be encountered because of too much memory will be needed.

- Image quality, contrast and noise ratio affect the algorithm's success in large scales.
- The linear feature's surface and cover qualities also affects the algorithm's success.

In order to be able to solve these problems and making the software more effective; for improving the contrast in images and lowering the noise ratios, filters like antisotrophic diffusion filter with including ability of the edge enhancement algorithms into developed approach, for filling the blanks that are caused by the large obstacles applying ability of the different interpolation methods and for handling the big sized images in computer environment the use ability of the pyramid levels will be studied.

RESOURCES

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