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SELECTION OF CLOSE CLASSES OBJECTS USING BRIGHTNESS HISTOGRAM

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Abstract. *The method for selection of close classes objects on a earth surface images is offered. A distinctive feature of a method is usage the histogram analysis with automatic selection of a threshold with a further filtration of the intermediate binary image via distance transforms.*

Key Words. *Earth Surface Images, Histogram Analysis, Distance Transforms, Classification.*

INTRODUCTION

In technology of updating digital maps on earth surface images the large attention is given to automatic and semiautomatic methods for separation of objects with the purpose of their subsequent description in the vector format [1]. The process of manual outlines of a contour takes a lot of time therefore his full or partial automation is rather vital problem.

The simplest method is usage of a histogram of brightness [2] for allocated objects. A main problem on this path is the overlapping of the range of histograms values for close classes objects. The method with automatic selection of a threshold with subsequent proceeding based on the distance transforms is offered.

1. SELECTION OF OBJECTS WITH USAGE OF A BRIGHTNESS HISTOGRAM

The histogram of object brightness has definite range of values. However pixels of a background can be distributed on all range of possible values and enough overlap values range of object (fig. 1, a). The offered method eliminates such uncertainty and limits range of values of the background in particular limits (fig. 1, b). The processing is realized in a semiautomatic mode and the operator selects rectangular object area at first time and then rectangular background area. The histograms of brightness are constructed on these areas.

The problem of recognition thus is transformed in a problem with two classes. If the pixel belongs to range of values for object and does not belong to range of values for background, it will be identified as an object pixel. If the pixel does not belong to range of values for object, it will be identified as a background pixel. The task of belonging take places only when the pixel is in the overlapping range. In the elementary case overlapped range does not include into object (fig. 1, c).

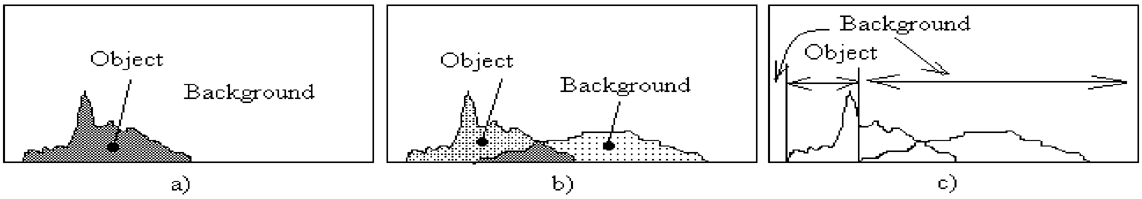

Fig. 1. A method to limit the range of a brightness of background: a) one class, b) two classes, c) recognition.

Let I is the set of pixels for initial image, B $\subseteq$ I – set of pixels of object,, G $\subseteq$ I – set of pixels of a background, and $B^h \subseteq [0,1,\ldots, N]$ – range, which one is received by pixels of object, and $G^h \subseteq [0,1,\ldots, N]$ – range, which one is received by pixels of background, N – the maximum brightness to be restricted by color depth. Then pixels i_{xy} with brightness $\varphi\ (\ i_{xy})\ \in\ (B^h/G^h)$ will be belong to object.

Such approach justifies itself if in the range of overlapping there is a great set of background pixels and minor quantity of object pixels. For example on fig.2, a, the input image with rectangles for constructed histogram is presented. In this case the overlapping range there was 14.47 % pixels of object and 96.79 % pixels of a background.

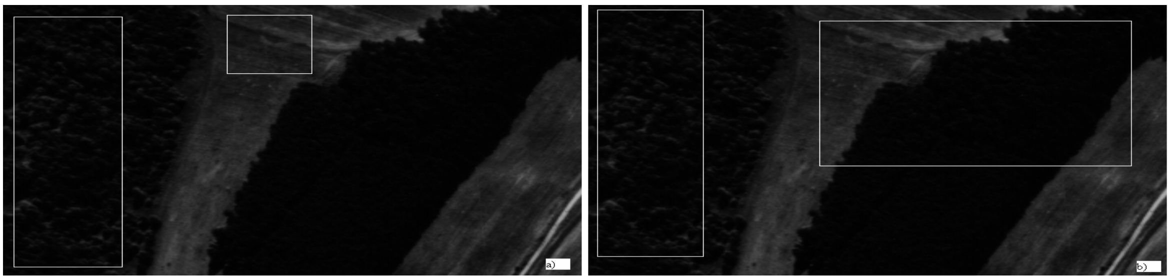

Fig. 2. The initial map with selected rectangles for constructed histograms of object and background :a) forest as object and field as background, b) deciduous forest as object and field with coniferous forest as background

On fig. 3, a, the result of such selection is shown. On the image there are false objects and false background being a forest but not recognized are represented. The linear sizes of false areas are much less than the sizes of object. To calculate linear dimensions distance transforms have been used [1,3,4]. As result the white and black areas with width lower then threshold are inverted. Result of such filtration is presented on fig.3, b.

For a number of cartography problems it is required to recognize objects of close classes, for example, coniferous and deciduous forest (fig.2, b). On a fig. 4 the histograms of object (deciduous forest) and background (coniferous forest and field) are shown. Thus in the overlapped range there is 100 % pixels for object and 97.53 % pixels for background. For this reason it is offered to eliminate not all pixels of overlapping range.

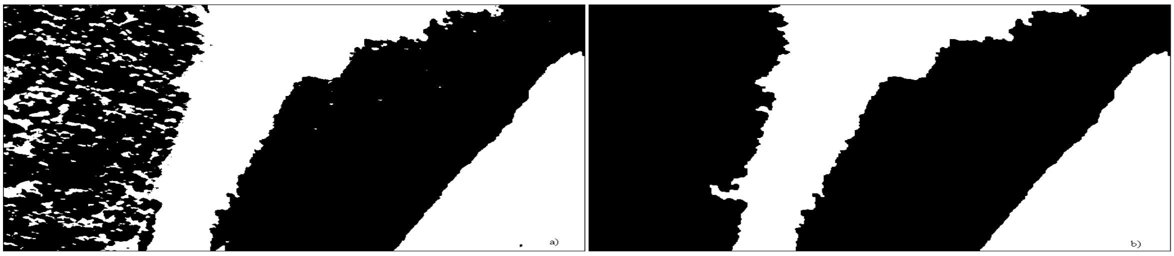

Fig. 3. Automatic selection of a threshold for selection of a forest: a) selection of object, b) filtration by distance transforms.

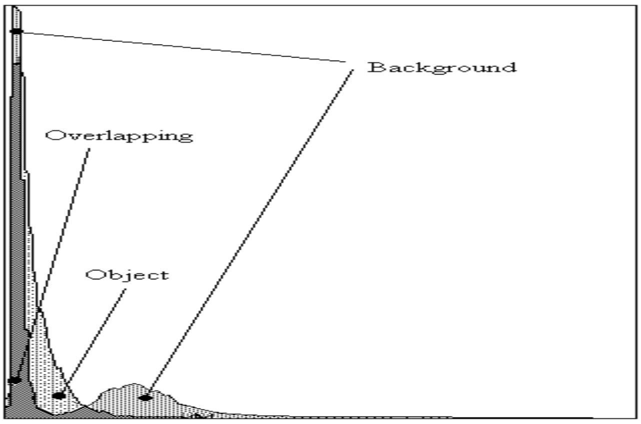

Fig.4. The histograms for object and background

2. SELECTION OF CLOSE CLASS OBJECTS

In the overlapping range the altitude of histograms of object and background can essentially differ. Threshold of this ratio is used for separation object and background. Let b_k is the relative quantity of the pixels of object with brightness k in total set of the pixels of object, and g_k - relative quantity of the pixels of background with brightness k in total number of the pixels of background. Pixels with brightness φ (i_{xy}) will belong to object if $b_{\varphi(i)} / g_{\varphi(i)} > s$, where s – given threshold.

Such approach extends cases with full exception of a background and without exception. So for s=0 all pixels of object will be selected without excluding of a background. Really, $b_{\varphi(i)} / g_{\varphi(i)} > 0 \Leftrightarrow b_{\varphi(i)} > 0$ or $i_{xy} \in B$. For $s \to \infty$ the excluding of a background take place: as $b_{\varphi(i)} / g_{\varphi(i)} \to \infty \Leftrightarrow g_{\varphi(i)} = 0$, $b_{\varphi(i)} > 0$ or $i_{xy} \in B$, $i_{xy} \notin G$. S=1 corresponds to a case when quantity of pixels of object of the given brightness exceeds number of pixels of a background for given brightness: $b_{\varphi(i)} / g_{\varphi(i)} > 1 \Leftrightarrow b_{\varphi(i)} > g_{\varphi(i)}$.

The method is critical to selection of a threshold and requires high proficiency of the operator. The given problem was decided by automatic selection of a threshold. The experiments have shown that the quality selection takes place at usage of quadratic relation:

$$s = \left(\sum_k b_k \Big/ \sum_k g_k \right)^2 \tag{1}$$

The calculation makes only for pixels of overlapping range. The threshold to be computed on the base of quadratic function is equal to 0.95. The results of selection are shown on fig. 5, a, where two forest areas were dedicated. However linear characteristics of these areas are various. Using filtration algorithm based on distance transforms with specially fitted different thresholds for black and white areas give results shown on a fig. 5, b. Results of the selection of a coniferous forest are shown in a fig. 5, c, d. In overlapping range there is 99.99 % pixels for object and 73.01 % pixels for background and the threshold of separation is equal to 0.389.

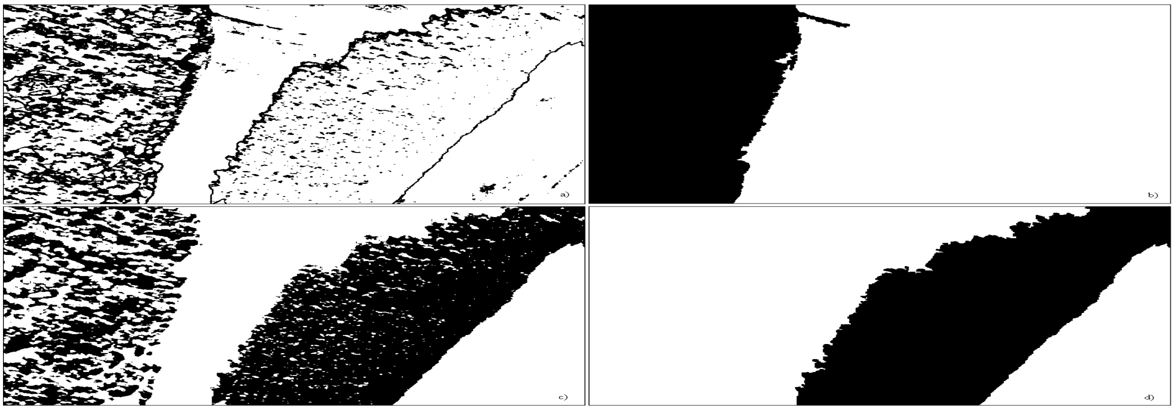

Fig. 5. Selection of the close classes objects: a) selection of a deciduous forest; b) a filtration of a deciduous forest; c) selection of a coniferous forest; d) a filtration of a coniferous forest.

CONCLUSION

The new method of semiautomatic selection of objects on the earth surface images is worked-out. Distinctive features of a method is the selection of a threshold for classification and application distance transforms for a filtration of false areas that gives opportunity for selection of the close class objects.

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