

The Method of Extracting the Contours of Objects from Satellite Images

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Abstract. Earth remote sensing data is used to solve many practical problems, for example, for digitizing satellite images. This problem can be divided into three stages, in this case let it be the classification of objects, the extraction of contours and creation of a vector layer. Neural networks, the support vector method, the K-means method and others can be used to classify objects. Good results on the extraction of edges are given by the Canny edge detector, Harris operator, Hough transform, and other methods. Creation of a vector layer is not trivial problem. In this article, we propose a method for extracting the contours of objects from satellite images. The idea of the proposed method is to combine a neural network and an interpreter of the SOQL language. The neural network allows finding quickly possible positions of the object on textural and spectral features and the SOQL interpreter extract contours of the object by structural description and create vector layer.

Keywords: WPS, Pattern Recognition, Convolution Neural Networks.

1 Introduction

One of actual problems is the digitization of satellite images. It helps to solve the tasks of territorial management, such as resource monitoring, mapping, development planning and others. The problem digitization of satellite images can be divided into three stages: the classification of objects, the extraction of contours and creation of a vector layer. The first two of them are solved using well-known approaches. Neural networks, the support vector method, the K-means method and others can be used to classify objects. Good results on the extraction of edges are given by the Canny edge detector, Harris operator, Hough transform, and other methods. In this article we will consider the third stage of creating a vector layer, in particular the search for the locations of the buildings. It can be described as a problem of search of the closed contours on a set of the extracted edges. There are two sub problems at this stage, processing gaps between edges, determining the shape of the contour. The quality of the

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result depends on many factors, such as noise, distortion, brightness swings, overlapping objects, sensor position, etc.

In this paper, we propose combining two approaches to solve the problem of creating a vector layer. The first approach is a neural network; the second is an interpreter of the SOQL language [1]. Further consider the description of the SOQL interpreter. The SOQL interpreter searches for objects in accordance with a user's query which defines structural features. User's query is written in a language which has Prolog-like syntax. A query consists of descriptions of the straight line segments (boundaries), their geometric properties such as length and orientation. Each straight line segment is estimated by a membership function [2]. Object position is estimated by the energy function [3]. Object search is performed as logical inference.

2 Proposed method

The sequence of steps for creating a vector layer by the proposed method is as follows:

- 1) preparing a training set which includes examples of object to search with any shape;
- 2) training of a neural network;
- 3) segmentation based on textural and spectral features (use of a neural network);
- 4) searching for exact positions of objects (using the SOQL interpreter).

Let's consider each step in more detail. The first step is preparing training set for CNN in any GIS based on existing vector layer, which stored in SHAPE file. [4, 5]. For example SHAPE file can obtain from OSM service. While applying existing vector layers it is necessary to combine a vector file with corresponding image. The main difficulty in solving this task is the displacement of the vector layer relative to the image. This is due to different shooting angles or changes in objects over time. Figure 1 shows examples of errors. There are several ways to solve this problem. In this work, manual marking was used.

The next step is training the neural network. We used a pre-trained neural network of known architecture U-net for image segmentation. Pre-trained models require less training time, since the weighting coefficients are already defined. In the learning process, they are adjusted for user data, which is useful when there is little training set. The training set has been made from 720 – images, the size 128 x 128 pixels, that show in figure 2. In figure 3 and 4 shows the original image and the result of segmentation (step 3).



Fig. 1. Errors

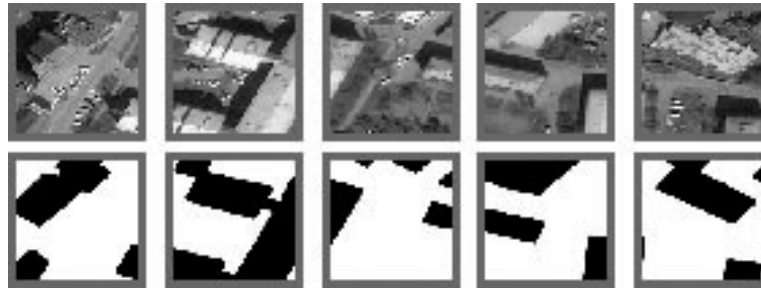


Fig. 2. Training data set



Fig. 3. Original image

Figure 4 shows that the boundaries of objects are distorted. To fix this, consider step 4 – definition of positions of objects. In the step 4 the SOQL interpreter is used to refine the position. The SOQL interpreter searches for objects in accordance with a user's query which looks like: $\text{rectangle}(A,B,C,D) :- \text{line}(A,B), \text{line}(B,C), \text{line}(C,D), \text{line}(D,A), \text{dist}(A,B) > 25, \text{dist}(A,B) < 40, \text{dist}(A,B) = \text{dist}(C,D), \text{angle}(A,B,C) = 90, \text{parallel}(A,B,C,D)$. It is suitable for finding a rectangle. Which have length 40 and weight 25. The SOQL interpreter is based on logical inference. The logical inference machine carries out search of objects positions that satisfying the user's query, starting from key points. The user's query may be generated automatically based on vector

layers. The key points are the corners of buildings; in order to find them Harris corner detector is used. The result is shown in Figure 5.



Fig. 4. Result of segmentation



Fig. 5. Key points

3 Conclusion

The method was tested on images of the Irkutsk city. The use of the interpreter in combination with the neural network allows create vector layer. Figure 6 shows the result of finding objects by the proposed method.

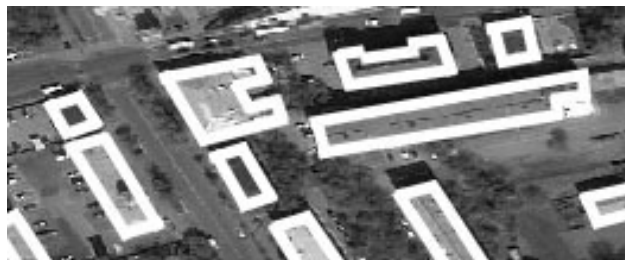


Fig. 6. The result obtained by the proposed method

The proposed method is effective with a small set of training data, allows you to process blurred images such as noise, distortion, brightness swings, overlapping objects,

sensor position, etc. It can also extract the contours of objects of a given shape. Unlike other methods [6], the shape of objects is set using the description in the SOQL language, this gives the advantage of fine-tuning the method.

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