

## **TEXTURE SEGMENTATION OF SATELLITE IMAGES BY NEURAL NETWORKS APPROACH**

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### **Abstract**

The goal of this paper is to present the results of design of a texture segmentation system for satellite images. Within the context of this system the algorithms of texture features calculation and the results of researches the neural networks approach for segmentation and clustering problems are generalized and presented.

### **Introduction**

The remote sensing problem is a part to the digital image processing. Recently the earth remote sensing is a base method in geoinformation technologies.

The simplest widespread practice is an elementwise (pixel) classification of satellite images with the use of their spectral brightness. However it often gives incorrect decision. The majority of classes which are presented in satellite images have high variability of reflection characteristics. Therefore development of more effective methods for the analysis and recognition of satellite images is very important when the problem of contextual information is growing. This information can be taken from statistical coherences of the neighboring elements of an image and a spatial data structure. Therefore exploiting texture analysis methods of images is a more promising way [1-4].

Another direction for perfection the remote sensing image processing is the usage of artificial neural networks (NN). NNs may be applied for realizing a wide class of functions without imposing any restriction on their distribution [5-7]. The development of effective algorithms based on the NN which are used for similar tasks is of a current importance. Such algorithms have a wide spectrum of applications and allow extention at the opportunities of traditional methods for the remote sensing image processing. Based on a topicality of the given approaches authors present the texture segmentation algorithm by neural networks approach.

In the presented system of the textural analysis it is necessary to allocate following points (fig. 1):

1. Choice the system of textural attributes.
2. Definition by an expert a number of classes and fix of texture samples for each class.
3. Choice by an expert the NN architecture.
4. NN learning by texture samples.
5. Image segmentation.

### **System of texture features**

In the texture analysis usually the following approaches [1, 2] are applied: the statistical methods, the geometrical methods, the modeling methods and the signal processing methods.

Statistical methods of the texture analysis are the best approach for applied remote research because natural processes have casual character. Statistical methods draw texture features with mathematical tools such as autocorrelation function, discrete transformations, gradient information, morphology, gray-level matrixes, models of gray-level spatial dependences and autoregressive models.

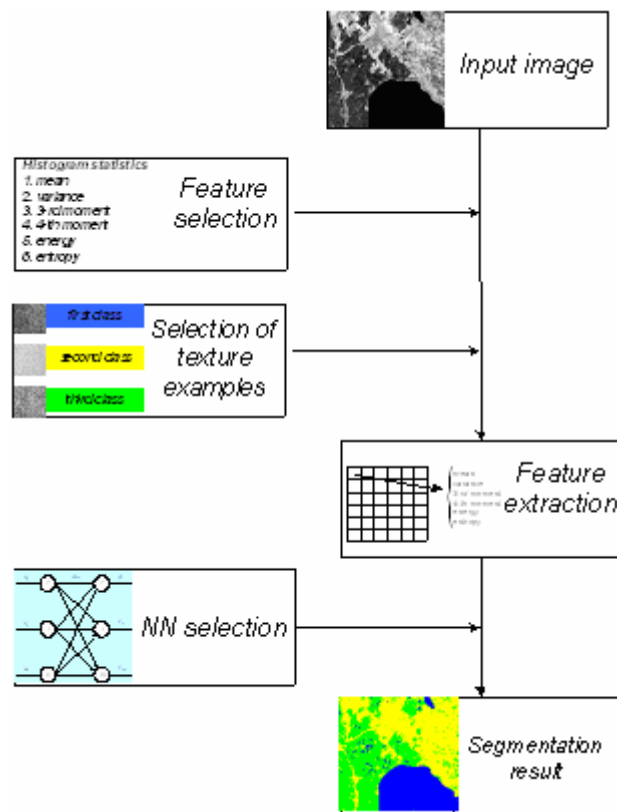


Fig. 1. Algorithm the texture segmentation for satellite images

Calculation of the following texture features (table 1) is suggested as they have the greatest self-descriptiveness [1, 2, 8, 9].

Table 1. System of texture features

GLCM texture statistics (Robert M. Haralick) [3]	Histogram statistics	Energetic textural Law's features
1. Angular Second Moment 2. Contrast 3. Correlation 4. Sum of Squares: Variance 5. Inverse Difference Moment 6. Sum Average 7. Sum Variance 8. Sum Entropy 9. Entropy 10. Difference Variance 11. Difference Entropy 12, 13 Information Measures of Correlation 14. Maximal Correlation Coefficient	15. Mean 16. Variance 17. 3-rd moment 18. 4-th moment 19. Energy 20. Entropy	21. Average value of the «energy»

System of texture features (table 1) includes the texture features proposed by Robert M. Haralick, which are calculated using gray-level co-occurrence matrix (GLCM), and the texture features received from histogram statistics. Besides, calculation average value of "energy" adopted from K. Laws proposed, is presented to calculate. The algorithm for calculation the

given value is proposed by authors in [9, 10]. The presented system of texture features is maximal and can be corrected by the expert. After definition of the number of classes on the initial image the expert chooses texture samples for each of them and makes calculation of reference texture features.

**The neural networks used in presented system for segmentation of satellite images**

The database of NN architectures of the presented system provides the decision of a problem of texture segmentation using following NNs:

- Multi Layers Perceptron (MLP);
- Radial Basis Function (RBF);
- Self-Organizing NN .

Topologies of the listed NNs are presented on fig. 2.

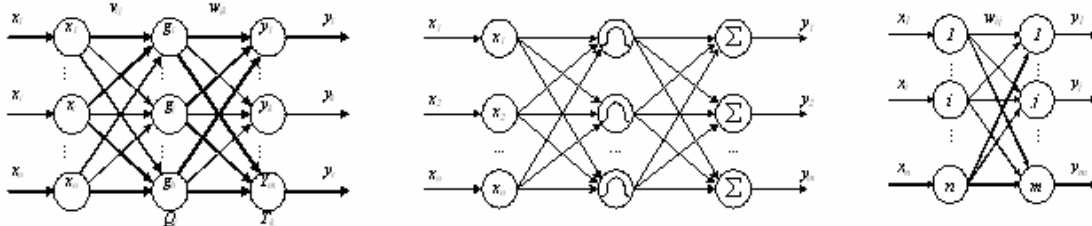


Fig. 2. NN Topologies for texture segmentation

MLP and RBF are learned using the algorithm of back propagation error. The self-organizing NN are those that are used for unsupervised learning. Such networks are applied for clustering.

**Experiments Results**

Our experiments results demonstrate, that the greatest self-descriptiveness offered first four possess texture features, proposed by Robert M. Haralick, and the features which are calculated using histogram statistics, exception for "Entropy". Also results improvement shows use at formation of system of textural attributes of average value of "energy".

From the presented NNs the best results on recognition and training speed was shown by RBF. It is important to remark, that such network can be applied as the classifier with a success in case of good classes clustering in feature space. Otherwise usage of MLP is preferable.

Segmentation results of the radar image from TerraSAR-X satellite with the usage of the system of texture features and MLP that presented before are shown on fig. 3.

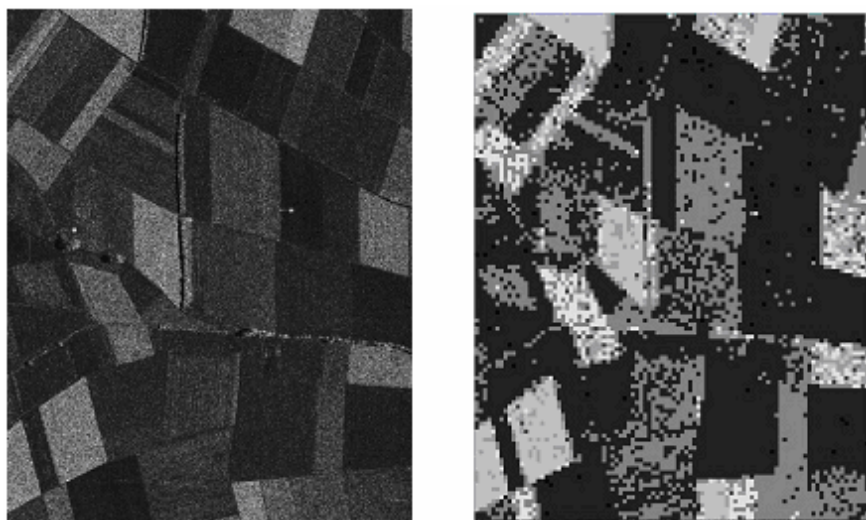


Fig. 3. Segmentation results for the radar image from satellite TerraSAR-X

Segmentation results of the image from Landsat 7 ETM + satellite with the usage of the system of texture features and self-organizing NN are shown on fig. 4.

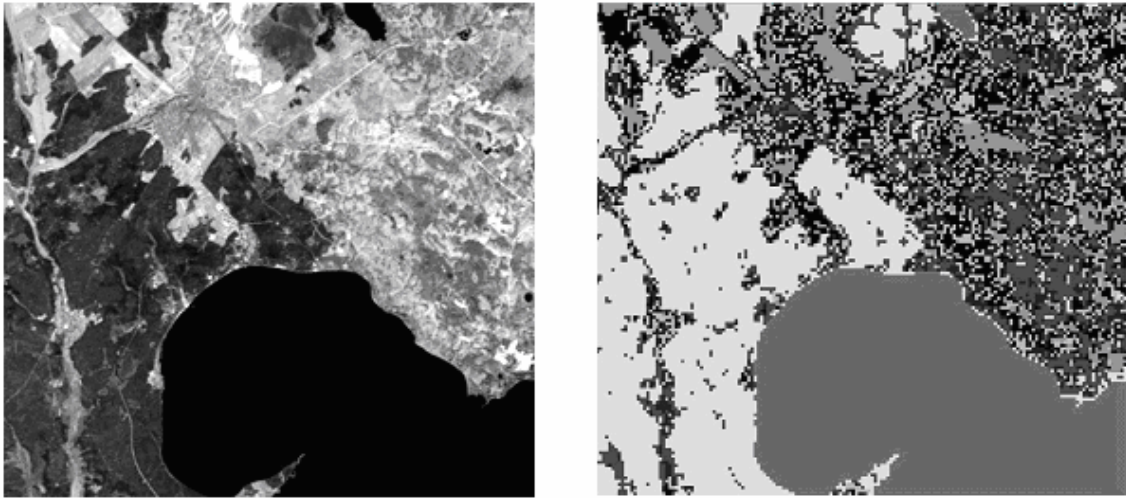


Fig. 4. Segmentation results for the image from satellite Landsat 7 ETM+

### **Conclusion**

We present the structure of texture segmentation system for satellite images which has united the results of research on an effective unitization of NN for segmentation problems. The system of texture features with both well-known features and features calculated on algorithms provided by authors is presented.

### **Literature**

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