Training Methods of Geospatial Remote Sensing Data Processing

A.V. Sosnovsky, V.G. Kobernichenko, N.S. Vinogradova

Ural Federal University, Yekaterinburg, Mira str. 19, 620002 Russia
sav83@e1.ru

Abstract. Techniques of active learning in thematic processing methods of multispectral and radar remote sensing of the Earth data for undergraduate and graduate students for the «applied informatics», «radio engineering», «information security» master programs on the basis of software and hardware of the Space monitoring center of the Ural Federal University are considered. It is shown, that exploratory laboratory works and individual or group projects are quite suitable forms for the active training for the methods of remote sensing data processing. Themes of exploratory laboratory works and projects themes are revealed.

Keywords: remote sensing image processing; geospatial data processing; data classification and recognition; active methods of training; master's educational programs

1 Introduction

Remote sensing data in recent years have become available to a wide range of users and are actively used to solve a variety of technical problems, i.e. automatic detection and recognition of objects, monitoring of territories for assessment of both natural and anthropogenic processes development at different scales and with different accuracy, generation of digital terrain models, assessment of relief displacements of the earth's surface, etc. A qualified specialist solving the tasks mentioned above must possess the basic theoretical and practical knowledge in the field of existing technologies of data processing and application of remote sensing data, as well as the skills and abilities of the correct choice and use of techniques and algorithms for processing and preformation of geospatial data [5]. In this regard, the task of ensuring the qualitative consolidation of knowledge, skills of data processing and interpretation is particularly relevant.

2 Active learning approaches for the geospatial data processing tasks

The use of active forms of education [1-3], encouraging students to think and practice in the process of mastering the educational material, to the manifestation of creative,

research approach and search for new ideas for solving various problems of the subject field, allows to achieve a deeper understanding of the essence of geospatial data and methods of their processing [4], as well as the possibilities and limitations of methods of computational mathematics, mathematical statistics, the theory of algorithms, the pattern and scenes recognition theory. Taking into account the peculiarities of the studied material, the most suitable active forms of training were search laboratory works and project work (individual and group projects). Examples of exploratory laboratory works with elements of scientific research conducted in the classroom (4 acad. hours) are listed below.

1. Classification of multispectral remote sensing data (disciplines «digital image processing», «remote sensing data processing»). Students are tasked to implement one of the specified supervised classification algorithms (rectangles algorithm, minimum distance, Mahalonobis distance, maximum likelihood algorithm, etc.) using any of the previously studied application development environments (usually MATLAB, C/C++ or Python are selected) and to compare the classification result of a particular of image data sample (usually fragments of LANDSAT-7/8 or SPOT-4 images are used) with the classification results of specialized software (ENVI, ERDAS). The variability of tasks is provided by the choice of different classification algorithms and different types of classified data. As a result, students improve the programming skills in the algorithms development, as well as consolidate knowledge and skills in the field of pattern recognition theory.

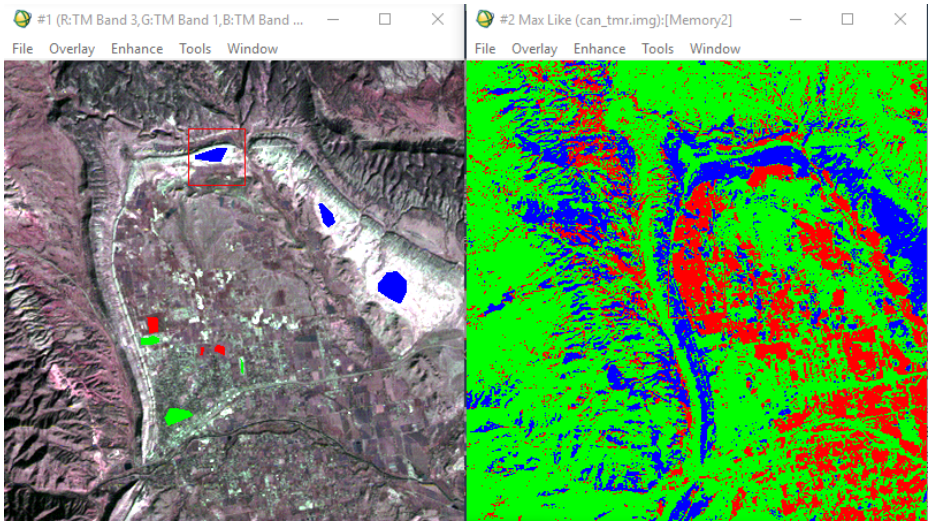

Fig. 1. A step of exploratory laboratory work «Classification of multispectral remote sensing data».

2. Spatial data georeferencing (disciplines «fundamentals of remote sensing of the Earth», «geoinformation systems»). Students are given the task to implement using the application development environment a method of automatic space image warping using three reference points extracted from the image metadata. The variability of

tasks is ensured by the selection of different scenes and data storage formats. The result is evaluated visually. As a result of the task, students consolidate their knowledge and skills in the field of affine geometry and data interpolation methods.

Fig. 2. A step of exploratory laboratory work «Spatial data georeferencing».

3. Generation of matrix (GRID) digital elevation models using cartographic materials (disciplines "digital terrain models", "geoinformational systems"). Groups of students (2-3 people) are tasked to form a matrix of elevation using interpolation algorithms implemented in the application development environments MATLAB and Python (Delaunay triangulation, ScatteredInterpolant), and to compare it by the stereometric method for the same territory. Upon completion, the results obtained by individual groups are combined, and a discussion is held on the acceptability of the obtained deviation values in solving real production problems. As a result of the task execution, students consolidate their knowledge and skills in the field of mathematical statistics, software processing of vector geospatial data and processing of measurement results.

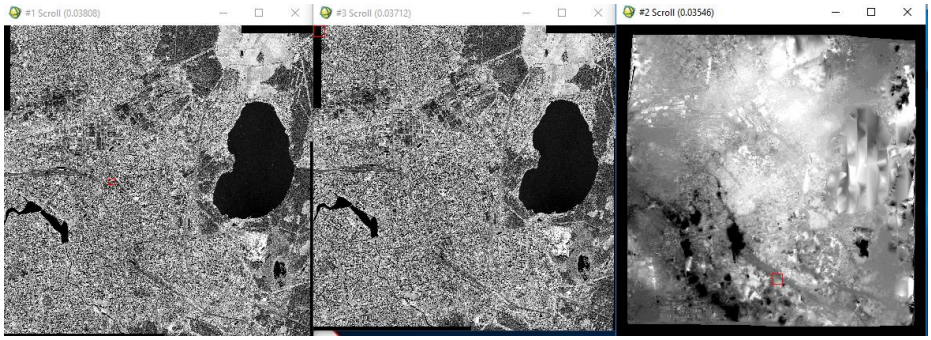

Fig. 3. A step of exploratory laboratory work «Generation of GRID digital elevation models».

More voluminous tasks with elements of scientific research and a wide application of software development tools are performed in the form of course projects, module projects and final qualification projects. The examples of such tasks are listed below.

1. Development of software for automation of space data receiving by a station «SCANEX UNISCAN-24». In the framework of the module project on the final qualification project the student is to develop an application (or system service) that performs real-time first-stage processing of satellite data at the end of the communication session. Variability and continuity of development are ensured by the use of different application development tools and different formats of processed data (MODIS, Meteor-M); up to 2013, the development of SPOT-4 and RADARSAT-1 primary data processing automatization was also carried out. In the course of solving the problem, the student acquires and consolidates knowledge in the field of algorithm development and automation of production processes.

2. Modeling of flood zones. The student gets a task for his course projects (module project or final qualification project) to make a literary review of the subject area and implement the algorithm for calculating the flood zone in the framework of the geometric approach in the presence of a digital terrain model and compare the results with the model obtained in a specialized PC (*i.e.* HEC-RAS) in the framework of the hydrodynamic approach. In the course of solving the problem, the student, in addition to acquiring and consolidating knowledge in the fields of geoinformatics, algorithm development and mathematical modeling, gets an understanding of the depth of complexity of real practical problems and the limited applicability of simple methods of solving them.

3. Research of efficiency and modification of radar interferometric remote sensing data processing methods. The student is invited to conduct a literary review of specific methods of interferometric processing, such as methods of phase noise suppression or phase unwrapping, and modify any of the existing methods or propose a new one. The efficiency of the developed method is compared with the efficiency of other methods implemented in specialized software systems (SARscape, PHOTOMOD RADAR) according to the existing methodology.

4. Investigation of the possibilities of open remote sensing data archives. The student is to produce an analysis or research of the geoportal or service for access to the satellite imagery data archives (EarthExplorer, Copernicus, LandViewer, JAXA G-portal, etc.) for availability and diversity of the data provided (in relation to the number of model and scene modes, territorial and temporal coverage), and to draw and analyze maps of the change areas using archive materials. In the course of solving the problem, the student acquires and strengthens the skills of information retrieval methods, geospatial calculations and pattern recognition.

3 Conclusion

Thus, the use of active teaching methods (search laboratory works, individual or group projects) contributes to the better assimilation by students of the methods and principles of geospatial data processing, strengthens knowledge in scientific and applied areas of mathematical statistics, pattern recognition, processing of measurement results, automation of production processes.

The application of these methods allowed to increase, on the one hand, the effectiveness of the disciplines learnt, on the other hand, to reduce the lecture volume in favor of practical training.

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