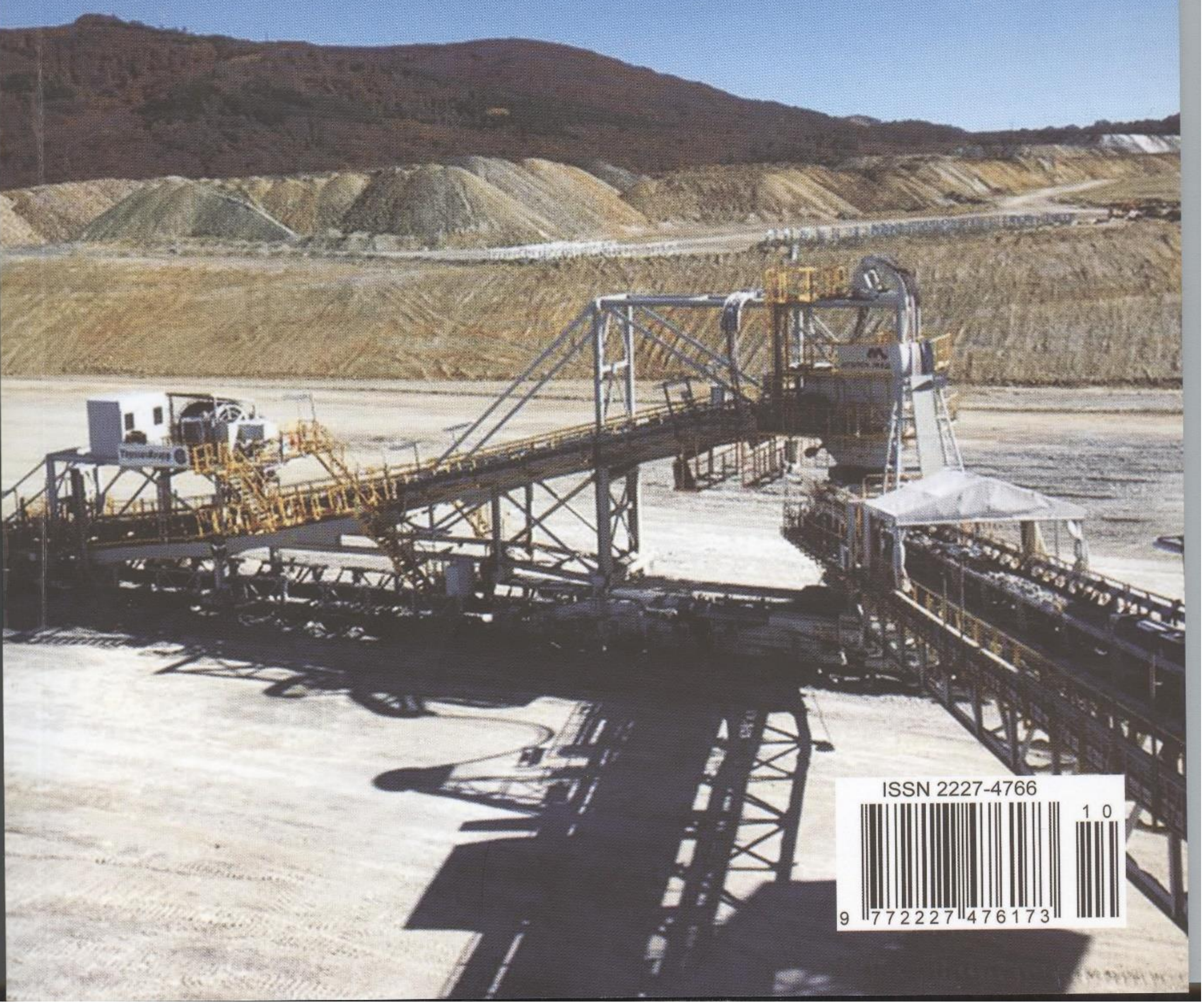
научно-технический и производственный

ГОРНЫЙ ЖУРНАЛ КАЗАХСТАНА

Қазақстанның кен журналы

№10 2017



ISSN 2227-4766

№10 (150) 2017

научно-технический и производственный

ГОРНЫЙ
ЖУРНАЛ КАЗАХСТАНА

зарегистрирован Министерством культуры и информации Республики Казахстан 04.04.2013 г. Свидетельство о постановке на учет периодического печатного издания 13508-Ж.

Издается с января 2003 г.

Приказом №1082 от 10.07.2012 г. Комитета по контролю в сфере образования и науки МОН РК внесен в перечень научных изданий, рекомендуемых для публикации основных результатов научной деятельности.

При перепечатке материалов ссылка на ***Горный журнал Казахстана*** *обязательна. Ответственность за достоверность сведений в публикуемых статьях и рекламных материалах несут авторы и рекламодатели. Мнение редакции не всегда может совпадать с мнением авторов.*

Адрес редакции: 050026, г. Алматы, ул. Карасай батыра, 146, оф. 401.
Тел.: 8 (727) 375-44-96

www.minmag.mining.kz

Представители журнала:

Центрально-Казахстанский регион –
ВЛАДИМИР ФЕДОРОВИЧ ДЕМИН,
vladfdemin@mail.ru

Российская Федерация, Москва –
ИРИНА ЯРОПОЛКОВНА ЩВЕЦ,
shvetsirina@yandex.ru

Российская Федерация, Сибирский регион –
ЮРИЙ НИКОЛАЕВИЧ ШАПОШНИК,
shaposhnikyury@mail.ru

Украина –
ВЛАДИМИР ИЛЬИЧ БОНДАРЕНКО
bondarenkov@nmu.org.ua

Периодичность 12 номеров в год

Тираж 1500 экземпляров

ISSN 2227-4766

Подписной индекс **75807** в каталогах:
АО «Казпочта»,
ТОО «Эврика-Пресс»,
ТОО «Агентство «Евразия пресс»

Подписано в печать **25.10.2017 г.**

Отпечатано:
Типография «ART DO»
Республика Казахстан
г. Алматы, ул. Натарова, 95
тел.: + 7 727 328-41-11

УЧРЕДИТЕЛЬ И СОБСТВЕННИК
ТОО «Научно-производственное предприятие «ИНТЕРРИН»

Главный редактор
М.Ж. БИТИМБАЕВ, *mbitimbayev@mail.ru*

Заместитель гл. редактора
Л.А. КРУПНИК, *leonkr38@mail.ru*

Заместитель гл. редактора
Х.А. ЮСУПОВ, *yusupov_kh@mail.ru*

Ответственный редактор
Ю.А. БОЧАРОВА, *Yuliya.Bocharova@interrin.kz*

Специалист по связям с общественностью
Т.С. ДОЛИНА, *Tatyana.Dolina@interrin.kz*

Помощник редактора
И.П. ПАШИНИНА, *Irina.Pashinina@interrin.kz*

Содержание

® – статья на правах рекламы
Ⓘ – информационное сообщение
✎ – статья публикуется в авторской редакции

UDC 526(08)

G.S. Madimarova[1], *Candidate of Technical Sciences, Associate Professor,* madimarovagulmira69@gmail.com
D.N. Suleimenova[1], *Master of Science,* Suleimenovad81@gmail.com
A.B. Saduakhas[1], *Lecturer,* saduakhas.amandyk@gmail.com
Sh.A. Zhantueva[2], *Senior Lecturer,* shnar_61@mail.ru

[1]*Kazakh National University named after Al-Farabi (Almaty, Kazakhstan),*
[2]*Noncommercial Joint-Stock Company «Kazakh National Research Technical University after K.I. Satpaev» (Almaty, Kazakhstan)*

REMOTE SENSING AND ELEMENTS OF DIGITAL IMAGE PROCESSING

Бұл жерде қашықтықтан зондтауды белсенді және белсенді емес кеңістіктік мәліметтерді талдауға қолдану үшін, бейнелерді жинақтаудан және әр түрлі әдістердің көмегімен пайдаланушы классификациясын алдын-ала өңдеу және пиксель-бағдарлау жағдайында сипатталады. Бейнені алдын-ала өңдеуге сандық талдау кезіндегі классификацияда жақсы нәтижесінде алу үшін түзету және жақсарту кіреді. Бақыланатын және бақыланбайтын әдістер классификациясын қолдану сарапшыға байланысты болуы мүмкін. Бұған қарамастан қашықтықтан зондтау беткі қабатпен, анықтау бойынша, осы саладағы алдыңғы біліміне қажет етпей-ақ сенімділік деңгейін бағалайтын классификацияны қолдану нәтижесін бағалауға мүмкіндік беретін сенімділік деңгейін көрсетеді.

Статья рассматривает историю создания первых аналогов дистанционного зондирования и развития этого направления, главным преимуществом которого является объяснение того факта, что дистанционное зондирование является средством получения информации без физического контакта с объектом, что очень облегчает работу, в отличие от наблюдений на месте. В статье объясняются этапы развития дистанционного зондирования и его функции, начиная с предварительной обработки, заканчивая улучшениями изображения. Статья показывает способы дистанционного зондирования и преимущества использования этого метода при цифровой обработке изображений.

Түйінді сөздер: *қашықтықтан зондылау, каналдар, классификация, аэрофотосурет, радиометриялық түзетулер, геометриялық түзетулер, сурет сапасын жақсарту, шындыққа максималды жақын түзету, сегменттеу.*
Ключевые слова: *дистанционное зондирование, каналы, классификация, аэрофотосъемка, радиометрическая коррекция, геометрическая коррекция, улучшение изображения, классификатор максимального правдоподобия, сегментация.*

The modern discipline of remote sensing arose with the development of flight. The balloonist G. Tournachon made photographs of Paris from his balloon in 1858. Messenger pigeons, kites, rockets and unmanned balloons were also used for early images. With the exception of balloons, these first, individual images were not particularly useful for map making or for scientific purposes. Systematic aerial photography was developed for military surveillance and reconnaissance purposes beginning in World War I and reaching a climax during the Cold War with the use of modified combat aircraft such as the P-51, P-38, RB-66 and the F-4C, or specifically designed collection platforms such as the U2/TR-1, SR-71, A-5 and the OV-1 series both in overhead and stand-off collection. A more recent development is that of increasingly smaller sensor pods such as those used by law enforcement and the military, in both manned and unmanned platforms. The advantage of this approach is that this requires minimal modification to a given airframe. Later imaging technologies would include Infrared, conventional, Doppler and synthetic aperture radar [1].

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on-site observation. Remote sensing is used in numerous fields, including geography and most Earth Science disciplines (for example, hydrology, ecology, oceanography, glaciology, geology); it also has military, intelligence, commercial, economic, planning, and humanitarian applications.

In current usage, the term «remote sensing» generally refers to the use of satellite- or aircraft-based sensor technologies to detect and classify objects on Earth, including on the surface and in the atmosphere and oceans, based on propagated signals (e. g. electromagnetic radiation). It may be split into «active» remote sensing (i. e., when a signal is emitted by a satellite or aircraft and its reflection by the object is detected by the sensor) and «passive» remote sensing (i. e., when the reflection of sunlight is detected by the sensor).

Preprocessing functions involve those operations that are normally required prior to the main data analysis and extraction of information, and are generally grouped as radiometric or geometric corrections. Some standard correction procedures may be carried out in the ground station before the data is delivered to the user. These procedures include radiometric correction to correct for uneven sensor response over the whole image and geometric correction to correct for geometric distortion due to Earth's rotation and other imaging conditions.

Radiometric correction is a preprocessing method to reconstruct physically calibrated values by correcting the spectral errors and distortions caused by sensors, sun angle, topography and the atmosphere. Picture 1 shows a typical system's errors which result in missing or defective data along a scan line[1].

Dropped lines are normally corrected by replacing the line with the pixel values in the line above or below, or with the average of the two.

Geometric corrections include correcting for geometric distortions due to sensor Earth geometry variations, and conversion of the data to real world coordinates (e. g. latitude and longitude) on the Earth's surface. The systematic or predictable distortions can be corrected by

[1]*Ravi P. Gupta (1991). Remote Sensing Geology. – Springer-Verlag Berlin Heidelberg.*
[2]*Swain P.H., Davis D. (eds) (1978). Remote Sensing: the quantitative approach. – McGraw Hill, New York Internet.*

Pic. 1. Destriping: correction of line dropout (source: IDRISI Tutorial).

accurate modeling of the sensor and platform motion and the geometric relationship of the platform with the Earth. Therefore, to correct other unsystematic or random errors we have to perform geometric registration of the imagery to a known ground coordinate system.

The geometric registration process can be made in two steps:

▪ identifying the image coordinates (i. e. row, column) of several clearly discernible points, called ground control points (GCPs), in the distorted image and matching them to their true positions in ground coordinates (e. g. latitude, longitude measured from a map). Polynomial equations are used to convert the source coordinates to rectified coordinates, using first and second order transformation. The coefficients of the polynomial are calculated by the least square regression method, that will help in relating any point in the map to its corresponding point in the image;

▪ resampling: this process is used to determine the digital values to place in the new pixel locations of the corrected output image. There are three common methods for resampling: nearest neighbour, bilinear interpolation, and cubic convolution (Lillesand T. at al, 2008).

Image enhancement is conversion of the original imagery to a better understandable level in spectral quality for feature extraction or image interpretation. It is useful to examine the image Histograms before performing any image enhancement. The x-axis of the histogram is the range of the available digital numbers, i. e. 0 to 255. The y-axis is the number of pixels in the image[3] having a given digital number. Examples of enhancement functions include:

▪ contrast stretching to increase the tonal distinction between various features in a scene. The most common types of enhancement are: a linear contrast stretch, a linear contrast stretch with saturation, a histogram-equalized stretch;

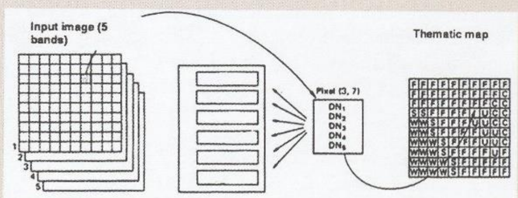
▪ filtering is commonly used to restore imagery by avoiding noises to enhance the imagery for better interpretation and to extract features such as edges and lineaments. The most common types of filters: mean, median, low-, high pass, edge detection.

Image transformations usually involve combined processing of data from multiple spectral bands. Arithmetic operations (i.e. subtraction, addition, multiplication, division) are performed to combine and transform the original bands into «new» images which better display or highlight certain features in the scene. Some of the most common transforms applied to image data are: image rationing: this method involves the differencing of combinations of two or more bands aimed at enhancing target features or principal components analysis (PCA). The objective of this transformation is to reduce the dimensionality (i.e. the number of bands) in the data, and compress as much of the information in the original bands into fewer bands.

Information extraction is the last step toward the final output of the image analysis. After pre-processing the remotely sensed data is subjected to quantitative analysis to assign individual pixels to specific classes. Classification of the image is based on the known and unknown identity to classify the remainder of the image consisting of those pixels of unknown identity. After classification is complete, it is necessary to evaluate its accuracy by comparing the categories on the classified images with the areas of known identity on the ground. The final result of the analysis consists of maps (or images), data and a report. These three components of the result provide the user with full information concerning the source data, the method of analysis and the outcome and its reliability. There are two basic methods of classification: supervised and unsupervised classification. In supervised classification, the spectral features of some areas of known land cover types are extracted from the image. These areas are known as the «training areas». Every pixel in the whole image is then classified as belonging to one of the classes depending on how close its spectral features are to the spectral features of the training areas. Picture 2 shows the scheme of supervised classification[4].

Training Stage. The analyst identifies the training area and develops a numerical description of the spectral attributes of the class or land cover type. During the training stage the location, size, shape and orientation of each pixel type for each class is determined.

Each unknown pixel in the image is compared to the spectral signatures of the thematic classes and labeled as the class it most closely «resembles» digitally. The most commonly mathematical methods can be used in classification are the following:



Pic. 2. Scheme of supervised classification.

[4]http://ltpwww.gsfc.nasa.gov/IAS/handbook/handbook_htmls/chapter1/chapter1.html
[3]http://www.satimagingcorp.com/gallery.html

▪ Minimum Distance: an unknown pixel can be classified by computing the distance from its spectral position to each of the category means and assigning it to the class with the closest mean.

▪ Parallelpiped Classifier: each class the estimate of the maximum and minimum intensity in each band is determined. The parallelpipedare constructed as to enclose the scatter in each theme. Then each pixel is tested to see if it falls inside any of the parallelpiped and has limitation. A pixel that falls outside the parallelpiped remains unclassified.

▪ Maximum Likelihood Classifier. An unknown pixel can be classified by calculating for each class, the probability that it lies in that class.

In unsupervised classification, the computer program automatically groups the pixels in the image into separate clusters, depending on their spectral features. Each cluster will then be assigned a land cover type by the analyst. This method of classification does not utilize training data. This classifier involves algorithms that examine the unknown pixels in the image and aggregate them into a number of classes based on the natural groupings or cluster present in the image. The classes that result from this type of classification are spectral classes. There are several mathematical strategies to represent the clusters of data in spectral space. For example:IsoData Clustering (Iterative Self Organising Data Analysis Techniques). It repeatedly performs an entire classification and recalculates the statistics. The procedure begins with a set of arbitrarily defined cluster means, usually located evenly through the spectral space. After each iteration new means are calculated and the process is repeated until there is some difference between iterations. This method produces good result for the data that are not normally distributed and is also not biased by any section of the image. The other one is Sequential Clustering. In this method the pixels are analysed one at a time pixel by pixel and line by line. The spectral distance between each analysed pixel and previously defined cluster means are calculated. If the distance is greater than some threshold value, the pixel begins a new cluster otherwise it contributes to the nearest existing clusters in which case cluster mean is recalculated. Clusters are merged if too many of them are formed by adjusting the threshold value of the cluster means [2, 3].

A supervised classification is based on the value of the single pixel and does not utilize the spatial information within an object. Because of the complexity of surface features and the limitation of spectral information, the results of traditional classification methods (pixel-based) are often mistaken, even confusion classification. Now a days we have some new methods based on the group of pixel. Segmentation is a process by which pixels are grouped into segments according to their spectral similarity. Segment-based classification is an approach that classifies an image based on these image segments. One of the process of segmentation employs a watershed delineation approach to partition input imagery based on their variance. A derived variance image is treated as a surface image allocating pixels to particular segments based on variance similarity (IDRISI TAIGA).

LIST OF SOURCES USED

1. *BüttnerGy. – Kosztra B. – Steenmans C. – Sousa A.: CLC2006: Mapping Land Cover of Europe under GMES. // 29th EARSeL Symposium, Chania, Greece, June 15-18, 2009. – Proceedings of the 29th EARSEL Symposium, Chania, Greece; edited by I. Manakos and Ch. Kalaitzidis, Milpress, 2010.*
2. *Madimarova G.S., Suleimenova N.D., Saribaev E.S. Geodetic Monitoring. // Republican scientific-methodical conference «The Role of geographical education in the third modernization of Kazakhstan». – 30-31 March, 2017.*
3. *Madimarova G.S., Suleimenova N.D. Monitoring of oil and gas fields. // Republican scientific-methodical conference «The Role of geographical education in the third modernization of Kazakhstan». – 30-31 March 2017.*

Abstract. The article considers the history of the creation of the first remote sensing analogs and the development of this direction. The main advantage is the fact that remote sensing is a means of obtaining information without physical contact with the object, which greatly facilitates the work, in contrast to local observations. Moreover, the article explains the stages of development of remote sensing and its functions, beginning with preliminary processing, finishing with image enhancements. The article shows methods of remote sensing and the advantages of using this method for digital image processing.

Key words: *remote sensing, bands, classification, aerial photography, radiometric correction, geometric correction, image enhancement, maximum likelihood classifier, segmentation.*

Статья публикуется по рекомендации члена редакционной коллегии, доктора технических наук Т.К. Калыбекова