PROCESSING OF ORTO-FOTO IMAGES FOR READ OUT DATA NECESSARY IN AGRICULTURE AND FORESTRY

PRELUCRAREA ORTO - FOTOPLANURILOR PENTRU EXTRAGEREA DATELOR NECESARE ÎN AGRICULTURĂ ŞI SILVICULTURĂ

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Abstract.*With preliminary processing aims at modifying the grey level of the pixels in order to obtain an adequate digital image for further processing. The characteristics of the processed image depend on the specific of the application and the destination. In order to improve the photo interpretation process — the accurate determination of the landmarks and cartographic details — a set of methods are applied to reveal the phenomens and objects of interest. The most frequent methods for improving image quality are: contrast improving, image filters, false coloured images, compound colour images and the analysis of the basic components.*

Rezumat. *Procesările preliminare au ca scop modificarea nivelului de gri al pixelilor în scopul obţinerii unei imagini digitale ce poate fi folosită în prelucrările ce urmează. Caracteristicile pe care trebuie să le intrunească imaginea prelucrată depind de tipul aplicaţiei şi destinaţie. Pentru o mai bună fotointerpretare se determină cu precizie punctele de reper şi se extrag detaliile cartografice cu ajutorul unor tehnici care au ca scop transformarea datelor iniţiale în vederea scoaterii în evidenţă a obiectelor de interes. Cele mai frecvente tehnici de îmbunătăţire a calităţii imaginilor sunt: îmbunătăţirea contrastului, filtrajul imaginii, realizarea imaginilor fals color, realizarea imaginilor în culori compuse şi analiza componentelor principale.*

Key words: *Remote sensing, processing, spatial filter, classification*
Cuvinte cheie**:** *teledetecţie, prelucrare, filtru spaţial, clasificare*

INTRODUCTION

Preliminary processing of remote sensing images is contrast improving. This relatively easy method is based on the linear or non-linear transformation of the grey level specific to every pixel in an image, so that the grey level should be distributed equally on the whole grey interval, from 0 to 255. In this respect the applied algorithms can be grouped in two classes:

1) direct mathematical functions — use simple algorithms that modify the grey values by following an independent mathematical relation against the grey level on the histogram. For example, a linear or logarithmic transformation can be done without taking into account the maximum or minimum values of grey.

2) statistic functions — the applied algorithms need a previous determination of histogram density. The image transformation will follow the match between the input and output value of the pixels.

Classification is a process of grouping data according to common characteristics. More specifically, classification is spectral pattern recognition, which categorizes Digital Number (DN) values of continuous (quantitative) data into distinct classes. Results are thematic (qualitative) data that represent specific categories based on spectral properties and/or ancillary data sources, and field verification.

MATERIAL AND METHOD

The typical histogram of an image with normal phenomena or object distribution is a Gauss curve (a bell). The more the curve that represents the normal Gauss distribution covers more grey levels ("the larger it is"), the more the image is considered to be better.

Applying modification algorithms to the grey scale has a number of limitations. The most important is that the grey scale modification is a global transformation: the same operation applies to all the pixels with the same intensity. This type of transformation can generate unexpected changes in image quality if the grey level distribution differs from a Gauss curve for other reasons than those connected with image degradation. It is the case of images that include areas of high amplitude and in which the variation in the grey levels is minimum or non-existent. An example is the large areas covered with water. In this situation, those grey levels modification algorithms will be applied that respect the context and treat the pixels that correspond to the large water-covered areas differently.

Another major limitation of the modification algorithms is that a certain modification that has a positive effect on some image classes can have a negative effect on others. Limitations occur when authorising image processing and the human operator intervention is then required.

Methods of spatial filtering

A spatial filter is a transformation in the value of image pixels based on the value of the neighbouring pixels. Spatial filters belong to the category of local image transformations because in order to calculate the new values are used filter models that imply the modification of all the pixels in the image. There are no restrictions regarding the shape and sizes of the neighbours. As far as digital image processing is concerned, the neighbours — also known as windows — are matrices chosen as square matrices with an uneven number of lines (columns), because in this way the neighbour can always be central on the current pixel.

Spatial filtering is a particularisation of the general operation called convolution in the image processing field and it applies operationally as follows:

a) neighbour (matrix) shape and size definition together with the corresponding weight for every pixel in the original image to be considered the matrix centre. This matrix is generally named operator or nucleus in the image processing field.

b) The window moves within the original image and its central value (the current pixel) in the resulted image is obtained by multiplying every weight with the corresponding pixel in the original image and finally adding the obtained products. This operation is performed for every pixel of the original image.

The spatial filters (Lilesand and Kiefer) are, like the spectral ones, a transformation of the pixel value. The spectral filters calculate the new pixel value regardless of other pixel values.

The method is based on what is called the weight matrices method. The image that is materialised in a number matrix breaks up in smaller matrices of uneven size (3*3, 5*5, 7*7, 9*9). The middle pixel is recalculated with a certain algorithm depending on the value of the weight and its neighbours.

56	48	52	60	98						
49	42	50	45	48		1/9	1/9	1/9		
48	51	45	48	60		1/9	1/9	1/9		49
51	49	44	48	50		1/9	1/9	1/9		

The nucleus is moved on all pixels successively and a new value matrix calculated to obtain the image. Depending on the weight of each element in the filter matrix, the image can be neat or it can have a stronger contrast.

Let's take a part of an image with a 3*3 nucleus and a 1/9 weight. The value of the central pixel will be calculated with the following algorithm:

56/9+48/9+52/9+49/9+42/9+50/9+48/9+51/9+45/9 = 441/9 = 49.

All the pixel values will be calculated with this algorithm. An example of frequent application that concerns filtering is the use of Sobel-type directional filters that are used especially in geology. They reveal certain directions of interest in relation with other directions that are less interesting for the structural analysis.

Table11

Sobel directional filter in order to reveal the geological structures

a)

1	2	3	2	1
1	3	4	3	2
0	0	0	0	0
-1	-3	-4	-3	-1
-1	-2	-3	-2	-1

b)

3	2	2	1	0
2	4	3	0	-1
2	3	0	-3	-2
1	0	-3	-4	-2
0	-1	-2	-2	-3

c)

-1	-2	-3	-2	-1
-1	-3	-4	-3	-2
0	0	0	0	0
1	3	4	3	1
1	2	3	2	1

(a) oriented northwards; b) oriented north west; c) oriented south ;

Methods of classification

The instantaneous visual field data are sub-classified in regions of equal shape and size called pixels. The sensors records the electromagnetic radiation and changes it into a digital number (DN). The DN value is the number of the reflected electromagnetic radiations that the sensor has captured. The higher DN values are represented as lighter pixels, while the lower ones are darker. The range of recorded numbers depends on the type of the sensor used. Many images are recorded as 2^8 ($2^8 = 256$) 8-bit-type data; in this case, the DN values for this type range form 0 to 255 (zero is considered a number).

For certain applications, such as water surface mapping, a single theme is enough. For others, like filed usage, several spectral channels are needed, if not all. The resulting thematic image is defined with the help of all the images obtained by applying the operations mentioned so far. Whatever the applied method, the classification or theme extraction requires two stages:

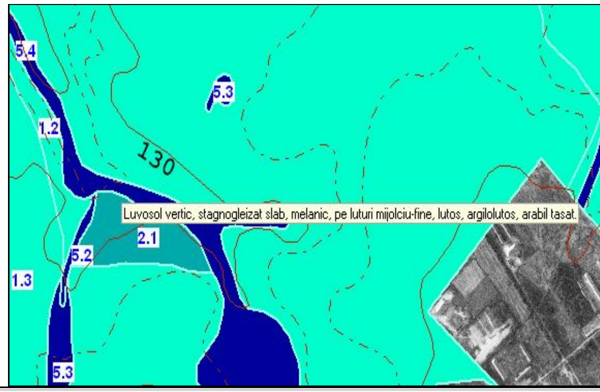
a) The identification of the groups and their association with statistical classes;

b) The classification of the multispectral image data contained in a single thematic layer.

Two basic methods can be applied:

1. supervised classification or supervised pattern recognition;
2. unsupervised classification or group analysis.

Supervised classification uses the known areas are used to train the classifier. It is an interaction between user and classifier.



5.3	Stagnosol gleic, pe depozite fluviatile mijlocii, lutos, lutos pasune
2.1	Luvosol vertic, stagnogleizat slab, melanic, pe luturi mijolciu-fine, lutos, argilolutos, arabil tasat.
1.1	Preluvosol stagnic, baticalcaric, erodat moderat, pe luturi mijlocii fine, luto-argilos, arabil tasat.
6.1	Vertosol stagnic, baticalcaric, pe argile gonflante, lutoargilos, lutoargilos, arabil tasat
5.4	Stagnosol molic-vertic, melanic, baticalcaric melanic, pe argile gonflante, lutos, lutoargilos, arabil tasat
5.4	Stagnosol molic-vertic, melanic, baticalcaric melanic, pe argile gonflante, lutos, lutoargilos, arabil tasat
1.1	Preluvosol stagnic, baticalcaric, erodat moderat, pe luturi mijlocii fine, luto-argilos, arabil tasat.
5.4	Stagnosol molic-vertic, melanic, baticalcaric melanic, pe argile gonflante, lutos, lutoargilos, arabil tasat
1.2	Preluvosol molic, stagnogleizat slab, pe luturi mijlociu fine, lutos lutoargilos, arabil tasat
5.1	Stagnosol vertic, stagnogleizat foarte puternic, melanic, pe argile gonflante, lutoargilos, lutoargilos arabil tasat
1.3	Preluvosol vertic, stagnogleizat slab, baticalcaric, pe argile gonflante, lutoargilos, arabil tasat
5.4	Stagnosol molic-vertic, melanic, baticalcaric melanic, pe argile gonflante, lutos, lutoargilos, arabil tasat
5.1	Stagnosol vertic, stagnogleizat foarte puternic, melanic, pe argile gonflante, lutoargilos, lutoargilos arabil tasat
5.4	Stagnosol molic-vertic, melanic, baticalcaric melanic, pe argile gonflante, lutos, lutoargilos, arabil tasat
2.1	Luvosol vertic, stagnogleizat slab, melanic, pe luturi mijolciu-fine, lutos, argilolutos, arabil tasat.
1.1	Preluvosol stagnic, baticalcaric, erodat moderat, pe luturi mijlocii fine, luto-argilos, arabil tasat.
5.2	Stagnosol luvic, stagnogleizat foarte puternic, melanic, pe depozite fluviatile, lutos, lutoargilos, fâneata

Figure 1. The connection between the satellite image and the reality on the field

Supervised classification is based on the previous knowledge of the surface characteristics of an image fraction and their use as decision factors in determining the proprieties of the other fractions. Pattern detection is one of the most delicate operations, more important than choosing a certain classification algorithm. The test areas are deduced from the measurements and do not exceed 1% of the whole image surface. In order o achieve the purpose, complex measurements concerning the information contents must be taken on the site.

The sites are chosen by specialists of the field for which the image processing is performed. This must meet the following requirements: they must be the most representative and provide accurate measurement possibilities; they must be accessible; they must be homogeneous; the determination types and their frequency must be established; statistically, every class must have a normal distribution.

The preliminary operations performed for this classification type are the following: the normal distribution is checked; the median and the standard deviation are calculated for every category in every spectral channel; the covariance matrix is calculated for every category (this matrix expresses the quantitative relation between the answers in different spectral channels); a matrix is calculated to indicate the separability between every spectral channel in order to check whether any two categories are disjunct or not; the spreading chart is drawn between different spectral channels in order to deduce the relations between the spectral answers in different channels for all the categories.

Unsupervised classification is an automatic method of the derived pixel groups with similar spectral characteristics. The user has to analyse the groups and attach a certain type of earth crust coverage in order to provide them with a meaning.

Unsupervised classification is the process of creating pixel groups that represent geographic characteristics without the previous knowledge of what is being classified. The spectral answer of all pixels is analysed with statistical methods. Is it the user's responsibility to decide the signature of these groups.

A standard grouping method that applies in unsupervised classification is iterative self-organising data analysis (ISODATA). This means that the image must be initially separated into equal data dispersion areas based on a number of classes determined by the user. Every pixel is evaluated based on the distance if its value to the group mean and then added to the nearest group. The spectral distance of every pixel is re-evaluated after the group signature is adjusted. The process is repeated until a certain relevant percentage (defined by the user) will characterise a class. The resulting classes of spectral signatures are so evaluated that every geographic characteristic will be as well represented as possible. The evaluation is based on the interpretation the user gives to the resulting image.

Sometimes certain classes can be eliminated because they have too many characteristics on small areas. Other times the classes can be joined because they represent the same object classes. A larger class that lacks homogeneity can be split in several smaller subclasses.

The procedure goes on as follows: the first pixel is assigned to group 1. Then the distance from the second pixel to group 1 is calculated. Is this distance is smaller than a certain threshold (the previously value given), then it will be included in group 1; otherwise it is assigned to group 2. Next the third pixel is taken and by measuring the distance it will be decided whether it belongs to group 1 or 2. If the threshold is exceeded, it will be assigned to group 3.

The following aspects characterise unsupervised classification: it not require special knowledge of the studied area; it reduces preconceived ideas to a minimum, and the classes do not have to have the signature the users wants (for instance, if the study concerns the vegetation in a barren ground, the result will be a thematic image on the soils); class interpretation may rise difficulties; as the group number is unknown, certain classes allow further processing by joining the classes with similar signature or dividing a class into smaller sub-classes.

RESULTS AND DISCUSIONS

The selection of the characteristics requires the selection of the useful information that will be used to classify the rest of the image in the landscape. The main purpose is to decrease spatial measurements dimensions and reduce data redundancy to a minimum. In this way, the volume of the data to be processed is smaller. Characteristics selection offers the following possibilities: (a) to select those characteristics that are minimum in a class of variability and maximum between classes, or (b) to select those characteristics that are as poorly correlated as possible.

The selection of the classification type requires the division of the characteristics space into disjunct spaces so that any pixel may belong to a class. There are three main classification types: geometrical (based on distance), parallelepiped, probabilistic and functional.

Geometric classification is based on the distance measured between the unknown pixel and a median vector. The pixel will be added to that class for which the distance is the smallest. An unknown pixel is classified depending on the distance between the pixel value and the mean of every category.

For the calculus of the probability that a pixel should belong to a certain category, the probability density function is used. After evaluating the probability of every category, the pixel will be added to that class for which it has the highest value. However, if the probability is lower than the determined threshold, the pixel is considered "unknown" and it will not be classified.

Functional classification associates a certain function to every class ands adds the pixel to that class for which the function value is the highest. The form of the function is chosen empirically and the experience in image processing, as well as site selection are decisive.

The chief characteristics of supervised classification are the following: the previous knowledge of the fraction of the channel that is to be classified; the sites may not be representative as a whole for a certain class and then the final image can lack accuracy; as the signature of the obtained classes is known, it is not necessary to interpret each of them; the image characteristics that must be separated and are not studied before will lead to a wrong classification; the classification process is done according to the theme that the user has defined.

CONCLUSIONS

In supervised classification, the object classes on the Earth surface are known previously for certain restricted areas of the image they are called test areas or sites. An attempt is made to include them in patterns and elaborate rules that are to be extended to the unknown image fractions. In simpler words, the user identifies several image areas that are typical of every class that is dealt with. For instance, in trying to create a vegetation map of Romania's mountain regions, one must identify the cultivated farmlands, the pastures and the forests that can be obtained by using field monitoring techniques. The image analysis tries to assign every pixel in the image to one of the classes.

In unsupervised classification, the process is reversed. First the pixels are organised in classes, then one checks whether the classes have or lack signature. First the groups are built, then supervised classification is applied and the groups without signature are kept for the classification decision regarding the rest of the landscape.

The drawback is that there is no precise rule to determine the threshold, which is decisive for the classification process. In most cases, after the threshold had been established and a certain inadequate classification has been obtained, the procedure is started again for a different threshold.

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