AERIAL SPACE INFORMATION PROCESSING IN THE INTEGRATED GEOINFORMATIONAL SYSTEM OF FOREST MONITORING

M D Breido

All-Russian Scientific Research Information Center for Forest Resources, Moscow

ABSTRACT

Two-stage automated aerial space information processing on the basis of active interaction with the cartographic data base of the geographical information system is considered.Procedures for the solution of tasks of understanding and interpretation of aerial space information at the example of cartographic registration of major forest fires and assess of clear cutting consequences by space photographs are listed.

Procedures of actualization of the cartographic base data and compilation of the output thematic maps are decribed.

KEY WORDS: Aerial space information, Processing, Cartographic data base, Understanding, Interpretation.

1. INTRODUCTION

A large amount of aerospace information entering by forest monitoring and the limitation of terms needed to present these data for users require application of the automated methods for processing,analysis and interpretation.

Until quite recently,these tasks have been mainly solved with the help of empirical methods involving geoinformative and other knowledges of a person dealing with decoding at the level of speculative conclusions. Such approach reduces essentially efficiency and objectivity of the obtained results,as well as doesn't allow to realise to the full the advantages of remote sensing methods for forest surveillance,namely greater scope and systematic character of information acquiring,an opportunity to survey repeatedly the same area.

In the process of the aerospace monitoring,it's necessary to provide a full automatized cycle of processing and analysis of the data obtained by remote survey from the moment of data acquisition till their conversion into cartographic,statistic and other documents required by the controlling organizations for the purposes of decision-making.The necessity to perform for this aim a large number of complicated logical operations combining analyses of images and maps requires that the methods for digital processing of images and for the automatized cartography would be merged into a single complex using the specialized data bases.

Such desire becomes especially evident when solving tasks of the monitoring the changes in state of forests when it's required to superpose in geometrical way photographs with plans or cartographic materials and to obtain quantitative estimations of characteristics of the phenomena observed (for example,area and volume of cut wood,a degree of forest damages caused by natural calamities and anthropogenic influences, etc.)

On the other hand, an application of multizonal surveying and synthesizers leads to the increase of authenticity of videodata interpretation only on condition that one knows the basic characteristics of the area comprised by photographs (the composition of these characteristics is determined by a specific tasks to be solved).

In both cases the object can be achieved by means of the active interaction between videodata and geoinformation system;the spatially superposed quantitative and qualitative characteristics of the investigated areas are to be stored in the digital data base belonging to this system.

The realization of the described complex makes it possible to analyze and to comprehend the changes taking place in the forest and to arrange the dynamic digital cartography by means of the active insertion of changes discovered at photos into the cartographic data base.

2. BACKGROUND

The considered system is based upon the active interaction of the subsistems concerning input,processing, analyses,comprehension and interpretation of images with the superposed cartographic and attributive data bases,as well as with knowledge bases.The peculiarity of the mentioned system consist in the utilization of the mixed superposed data bases practically at all stages,beginning with the structured pyramidal input of images up to the cartographic mapping of the objects and changes of forest fund revealed according to photos.

Speaking about input,one implies not only conversion of images into a digital form but also their structuring, adaptation to the chosen infological model and attachment to the topographic bases of the map.

To attach any fragment of photograph and to indicate the sites which are of interest for user,the information is used from the cartographic data base.

The attachment is accomplished after visualization of a digitalized fragment and after finding of control points at the screen of the monitor.The check of correctness of attachment is brought about by means of calling from cartographic base the object boundaries and linear elements (lakes,rivers,roads, ets.) which are good distinguished at the photograph and with the help of transformation of their outlines into the visualized fragment of the photograph.Before being transformed, the outlines which were called from the data base are subjected to a geometrical conversion that takes into account the distortions appearing by surveying or cylindrical scanning by application of different types of equipment for Earth scanning).

To facilitate the check and the following search the sections for the detailed analysis (situated at the survey fragment of photograph),the digital image is previously contrasted and subjected to the morphological smoothing while the boundaries being unchanged.

The sections chosen for the detailed analysis (working fragments of the photo) are edges by the rectangular windows; coordinates of their angles are

changes,quality of forest fund and the maintenance of the ecological standards;it permits also to interpret the obtained results,to control entering of changes into the cartographic base and to form the output thematic maps according to the given criteria.

3. SPATIAL DATA DOMAINS

The expounded principles have been realized by using the complex of technical facilities and applied for the solving tasks consisting in registration (on the basis of space photographs) of consequences of large-scale forest fires and for the evaluation of re-counted automatically from the coordinate system of the screen into the coordinate system of the photograph (thanks to that,the adaptation of subsystem of reading these points is carried out),as well as into the coordinate system of cartographic data base that leads to the thickening of the network of control points.These temporary control points will be saved within the base during all the time needed for processing of the working fragments.

In case of need,inside of working fragments (let's call them 'fragments of the first level) one can choose the fragments of the second level,and so on.That sort of pyramidal input structure gives an opportunity to have a good look at each local section of the photo by the corresponding optimum enlargement,to take into account the mutual location of different objects,as well as to accomplish their attachment to each other and to the topographic basis of the digital data base by the precision sufficient for the practical purposes.

Processing,analysis and interpretation of each fragment of the photo are accomplished under conditions of geometrical superposition with the different layers of cartographic information corresponding to the given attributive declaration. Speaking about a layer of cartographic information,one implies a part of contour network (selected from the data base) which contains forest sites with the given characteristics.The latters are used for habituation of classificators,segmentation of the analyzed fragment,determination of boundaries of forest objects and sections of forest fund which have been changed under the influence of different factors.

The selection of boundaries contours and the sites is accomplished automatically and followed by the geometrical correction,by the conversion from the dot matrix form into the vector one and by the analytical transforming into the cartographic data base.

The geometrical correction eliminates errors made in the course of selections of contours (thickenings,loops,ets.) by means of the algorithms for recovering of contour networks;this corrections eliminates also distorsions in the forming of images (which were caused becouse of the equipment for Earth scanning) by means of the correction formulae based upon the taking into account the appropriateness of forming of the mentioned distortions.Contours being transformed into the base are then put over the source cartographic network and are duilt in it by means of the subdivision of arcs and contjurs in the spots where they intersect.

The joint examination of contours being selected at the photograph and the informations concerning forest objects during the past years (this information is contained in the cartographic base) makes it possible to estimate parameters of changes taking place in the forest after the carrying out of clear cuttings.

For the cartographic registration of fires one applies space scanning photographs of the medium resolution (approximately 200m at the land surface) within the spectral ranges 0,6-0,7 mcm and 0,8-1,1 mcm with the scale 1:2500000,as well as photographs of the high resolution (approximately 40m at the land surface) for the some spectral ranges with the scale 1:300000.

The graphic characteristics of photos being analyzed have led to the creation of three-stage automatized technology:
-creation of the digital topographic base for the region being investigated according to the map of the given scale.
-creation of the base contaning the coordinates of the seats of fires according to the photographs withing the spectral range 0,6-0,7 mcm.
-automatized processing of photographs of the spectral range 0,8-1,1 mcm coupled with the indications of the location of burnt out places in the forest on the basis of coordinates of the seats of fires (fixed in the cartographic base),with selection of the contours of burnt out places referring to the current year,with estimation of the areas of burnt out places and non-burnt sites,with entering of amendments into the data base,with the forming and the tracing of output maps.

To increase the precision of superposition of the photograph with the topographic bases,a preliminary condensing of the network of limit point is carried out for the map itself and for the survey fragment of the photograph.

While processing space photographs and creating the output maps,one applies the digital topographic base of the scale 1:1000000 (which is used for the purposes of the contour representation of areas passed by the large-scale fires and the calculation of the sizes of these areas),as well as the topographic base of the scale 1:5000000 for survey representation of places where fires have spreaded.

The estimation of consequences of clear cuttings being hilfilled is carried out on the basis of space spectrozonal photographs of the scale 1:250000 up to 1:300000 with the resolution of 7-9 m at the land surface;these photographs can be superposed with the digital forest management tablets of the scale 1:25000.

The attachment of the contours of forest management tablet to the topographic basis,editing of the contours and their recording into the specialized cartographic relational data are realized with the aid of the corresponding data-base management system.

The interpretation of the space photographs at the survey level with the purpose of exposure of changes of forest fund areas caused by clear cuttings is carried out by means of the superposition of the visualized digital fragments of photographs with contours of clearings from the past years and of the nonforested sites (these contours may be called from carto graphic base),as well as with contours of forest sites that had been covered with mature and overmature stands before the begining of the investigated period.

Comparison (perfomed on the basis of the programming) of characteristies of sections of the photograph which are inside of the contours of these

two classes of objects allows to select,with comparative ease,the boundaries of the nonforested sites at the moment under review.In the way of the comparing these boundaries with the boundaries of clearings and nonforested sites from the past periods (containing in the cartographic base),one can find the boundaries of sites corresponding to the changes caused by the cuttings during the current year.Finally, in the way of protecting contours of new clearings (corresponding to the mentioned new boundaries) into the contour network of the cartographic data base we can not only actualize this base,but also bring to light all kind of departures from the felling plans and the infringements of standarts for forest utilization.

The results of the performed analyses have a visual effect on the output thematic maps that may be applied by the forestry authorities when they come to one or another decision.