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IMPLEMENTATION OF THE REMOTE SENSING TECHNOLOGIES, LASER SCANNING AND GIS FOR MINING PROCESS OPTIMIZATION

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Abstract

Quantifying the impact of environmental factors in a mining area involves a large number of monitoring points and cover a large area of land. The quality of environmental factors we deduce in several ways, like surveying or analyzing the samples in laboratory that requires many time and in many situations, unjustified high costs.
This paper's purpose is to subject to attention a method that uses the new technologies in the remote sensing field in order to obtain secure information and low costs. This technologies are using in the same time GIS systems that are particularly useful in creating, analyzing and processing geo-spatial information.
Implementing this techniques I suggest that we can control and prevent the impact caused by mining activities, we can improve the exploitation techniques and the most important, we can assure the safety of the employers.

INTRODUCTION

The mining industry is the leader of global economy, both by volume, value, labor employment but also through the dependence of all the other sectors of the economy, in fact the entire society for natural resources.

Earth's crust resources require sophisticated technologies to be discovered, extracted and administrated.

The mining activity takes place eminently spatial, claiming in-depth knowledge of volumes of Earth's crust, in which are found row materials, spatial technologies being the most indicated to administer mentioned activity. As a geospatial technology leader, GIS represents the most indicated way to respond mining field requests, technology interoperable, comprehensive, special designed to compile, process, display, analyze and archive a very important volume of interdisciplinary data.

GIS is an expert system, it derives from a branch of artificial intelligence, and it enables embedding, formal concepts of database and database management system (SGDB), so that the information can be geo processed, modeled and analyzed correlative with remote sensing and aero-photogrammetry.

Remote sensing consists from obtaining information about an object of phenomenon without making physical contact with it. It uses aero-spatial sensors technology for identifying and characterize the particularities of the earth's surface and of all the phenomenon that runs in the environmental system through Earth-Cosmos interaction, using signals that are propagated of the electromagnetic radiation emitted by aircrafts and satellites, (Figure 1).

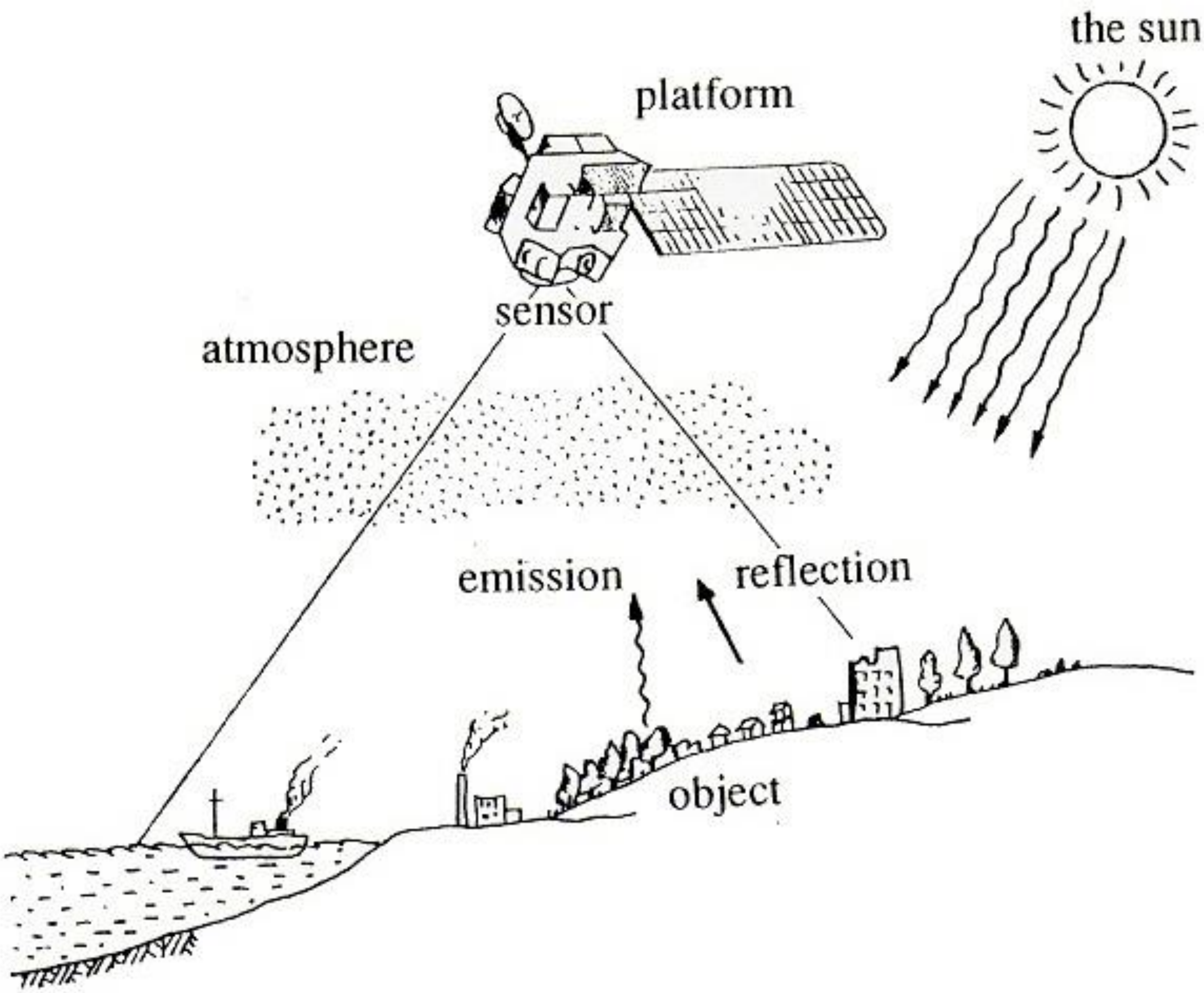

Figure 1. The operation of remote sensing

Remote sensing has multiple advantages that are continuously enhanced, which gives it large fields of application, of which mention:

- Satellite images cover synoptic very wide surfaces
- The collection, processing, interpreting and recovering of data requires minimum direct work.
- Have much more reduced costs than aero-photogrammetry
- Allow explore difficult to explore regions (to men)
- Because of its repetitive imagery character, allow in time study for observation a mining surface, evolution of a mine or the Earth's crust dynamics.

The method imposed by this paper consists in using the remote sensing technologies for ease the mining prospecting process; using laser scanning and aero-photogrammetry to improve the mining exploration, and not least; creating a GIS by means of which we can control directly the mining exploitation process and improving the management of the entire company.

Mining exploitation consists in:

- Opening works
- Preparation works
- The mining process

For the opening works it needs to execute: ores prospecting, procedure that consists in: geological research operations, geophysics and geochemical by which will be determined the existence of geological structures in which could be stored useful mineral substances, in determination of the ores contour and predetermining the ore's value from which to conclude if the exploitation is profitable or not.

GEOLOGICAL RESEARCH

Geological research can be performed much easier by using satellite recordings, especially the ones obtained by LANDSAT-TM satellites, this way we could obtain precise and detailed information about the nature and distribution of different types of rocks, petrography; identifying and characterizing geological structures at different scales, their correlation, by extrapolation, mapping of geological formations and improvement of mining exploitations both surface and underground.
Geological structures that contain useful mineral deposits can be detected through determining Earth's gravitational field by geodesic satellites, which report the nonhomogeneous recurrence of the masses in in the body of the earth crust.
These LANDSAT satellites are equipped with multispectral sensors which can record Earth's surface in 7 spectral bands, resulting massive databases.
The band used by recording surfaces in order to detect deposits of useful mineral substances is the band 7 (medium Infrared). The following picture (figure 2) represents an example of spatial capture to a topographic surface in this band.

figure 2. Spatial image captured by LANDSAT-TM satellite using spectral band 7

According to (table 1) we can observe the particularities of a few deposits that allow analyzing the images and help deduce the composition of the specific surface. I mention that with this images the soil component can be determined at a 6m depth.

LASER SCANNING

Raw satellite records are presented as form of impulses which can be converted in a coordinate system. Each impulse has, as correspondent, a value of time respectively the Cartesian coordinates (x,y,z), specific to the geographical position at that time.
The time component enters in system as a base information attribute and allows temporal observation over the production, forming this way the 4D system.
The purpose is to collect LIDAR (Laser Detecting and Ranging) data in order to realize the Digital Terrain Model (DMT) and the Ortho-photomap of the interest area.

Table 1.

LITOLOGY	
SANDSTONES	In humid climate
	In dry climate
SCHISTS	In humid climate
	In dry climate
LIMESTONE	In dry climate
	In dry climate
	In tropical climate
DOLOMITE	In dry climate
DYKES	
MORPHOLOGICAL MODELS	
SANDSTONES	Massive and abrupt slopes
	Smooth rock field
SCHISTS	Soft hill
	Circular hill with pits
LIMESTONE	Morphology karst
	Rocks plate
	Tropical karst
DOLOMITE	valleys and hills
DYKES	Massives or lineas
TEXTURE + HIDROGRAPHIC MODELS	
SANDSTONES	Dendritic, G
	Dendritic, angular, M, F
SCHISTS	Dendritic, M, F
	Dendritic, F
LIMESTONE	Intern model
	Dendritic or angular, M, F
	Intern model
DOLOMITE	Dendritic, angular, M
DYKES	Absent
TONES	
SANDSTONES	Luminous light gray
	Luminous stripped gray
SCHISTS	Erased gray
	Luminous stripped gray
LIMESTONE	Spotted gray
	Luminous light gray
	Luminous light evenly gray
DOLOMITE	Light gray
DYKES	Luminous light gray through dark gray

The surveying and LIDAR data collecting equipment consists in a twin engine aircraft, type DA 42 MPP, produced by Diamond Airborne Sensing (figure 3) on which are mounted the Riegl laser scanner and digital photogrammetry camera.

Figure 3. aircraft used for survey operations

On the surface are mounted GPS stations used at the measurements for determining the necessary data for post-processing trajectories and inertial data, at a certain density and after we place the pre-marked control points needed for conducting the aero-triangulation.

The work scheme of the survey operation (Figure 4)

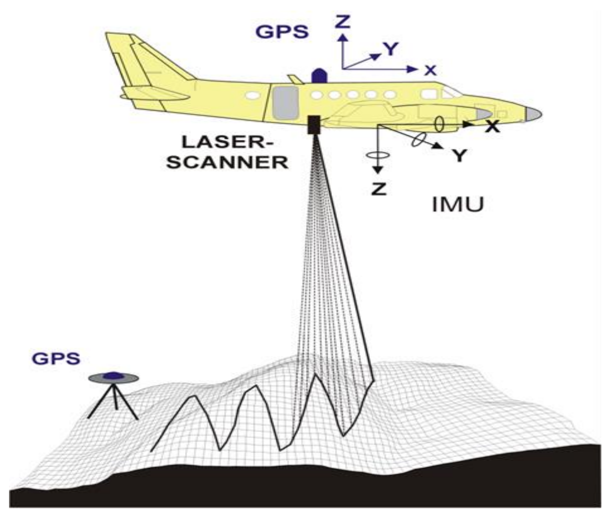

Figure 4. the laser scanning work scheme

After the flight, the next types of data are obtained:

- Inertial recordings (consist in the values of the aircraft's angles of inclination on the 3 axes (x,y,z)).
- GPS recordings (consists in the kinematic registrations of the GPS installed on the aircraft and GPS recordings of the station on the ground)
- Laser registrations (are formed from the points registered by the laser scanner in a chosen coordinates system)
- Digital imagery (include all the images made by the photogrammetric camera)

The link between recordings is the GPS time.

Aerial images, as the other images captured with different sensors, are always affected by geometric errors caused by terrain, the sensors position in the moment of recording, displacements caused by terrain in raw images, Earth's curvature, atmospheric refraction, constructive imperfections of the camera sensor. These errors can be corrected by using the Ortho-recovery, which means the transformation of the aerial photograms (central projections) in the Ortho-photograms (orthogonal projections).

The Ortho-photogram representation of the Earth's surface projected orthogonal on a reference plan or level 0.

GIS

In order to GIS can be personalized for the mining field it needs to be an integrated system in which all the internal managements practices must be gathered and interconnected in a unique system in which the process borders are not noticeable.

In other words, what we want from GIS is to allow us, to introduce and keep in a management system all database necessary developing optimally the mining exploitation, to ease considerably the work invested for maintaining the exploitation, to reduce costs and keep the employers safety and the quality of labor at a high standard.

Combining remote sensing, aero-photogrammetry and GIS represents the perfect solution for digitizing a mine, launching this way a new concept, namely DMMIS (digital mining management information system) this one operating with 3 information layers: the first layer (base), a GIS Archive X layer and an author interface layer.

This way we can improve the safety of the employers by decreasing the gas accumulation risk in the hewing, by mounting detection sensors of the concentration of toxic gases (methane), detecting the percentage of Oxygen, determining the air flow and speed, measuring the temperature, humidity and the pressure of the rocks in the hewing.

These sensors transmit to the "mother" system, information from the hewing without being needed human presence, so if there are irregularities, this can be prevented.

CONCLUSIONS

By creating a GIS system personalized on the conditions and requirements needed by the Mining exploitations, it could improve and assure mining activity duration and entire management and organization. . In this we recall all the information about: ventilation, lighting, conveyor belts from hewing; the skip which transports the ores from the hewing to surface; the construction of the new pits, the water blow-off from the pit, etc.

Retrospect to the mining exploitations from our country, where the exploitation is not executed with remote sensing, laser scanning and GIS, we can emphasize the importance and the advantages of these techniques in this field.

Still using old methods, the amounts of ores are lower or stagnant because the techniques used are no longer cope not only with the market demand but also to labor conditions which should've be assured to the employers.

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