Features of information visualization in coal quarrying

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Abstract. Today, such areas as coal mining, construction of large facilities, providing enterprises with coal (crushed stone, sand, etc.) reserves, etc., face a problem of providing all employees of a coal mining company with equally understandable information. This is bound to different qualifications of the majority of employees. However, as practice shows, the meaningful use of geographic information systems requires certain skills. Based on the aforesaid, it is possible to conclude that in order to be equally able to use the same information system by different employees, its maximum visualization and simplification of the graphical user interface are required. The results of the studies made it possible to test the presentation pattern by grouping the main functions of the software.

1. Introduction

Recently, the coal mining industry has been faded into insignificance among developers and integrators of software complexes (geographic information systems). However, the industry is strongly underestimated by manufacturers and integrators, which affects the development of relevant software solutions.

The collection and presentation of data at coal mining facilities is now carried out according to established technology. Information is collected in the following ways:

- Tacheometric measurements;
- Stereoscopic aerial photography;
- Surface laser scanning;
- Aerial laser scanning.

Collection, storage, processing and subsequent presentation of data in coal companies is mainly carried out using outdated GIS systems. Most of their functions are displayed either on a 2D or on a pseudo-three-dimensional map (a map represents a flat-surface substrate). Three-dimensionality in such systems is achieved by placing separate simplified 3D models of various objects on a substrate [1, 2]. As mentioned earlier, in terms of organization and functionality the work in these systems is extremely difficult for non-experts.

All this makes it very difficult for senior and middle managers (not directly related to coal mining) to access most of the information stored in GIS. Accordingly, there is a need for modern multi-module geographic information systems that can be scaled both by the structure as a whole and by the interface in particular based on various kinds of tasks.
2. **Graphical interface**

As part of the ongoing study, a program with an experimental graphical user interface was developed, in which scalability is achieved by combining functions into modules activated separately depending on their purpose [3]. The connection of these modules to the core of the system is arranged only if they are accessed from the corresponding program menu, which significantly saves the system resources and allows them to be distributed to visualize the environment and work with the database. Such an implementation has one disadvantage associated with long waiting period when first accessing the necessary module after starting the program.

3. **Example of implementation**

Let us consider the implementation of this GIS concept using the example of an open-pit coal mining.

In a specific case, there is a variety of different company divisions engaged in the work of quarries (logistics, surveyors, mine survey staff, management, etc.). With varying degrees of confidence all of them are quite familiar with standard plans and maps, not to mention GIS systems [4, 5].

For employees having insufficient understanding of plans, maps and GIS, the software complex looks as simple and intuitive as possible (Figure 1).

![Figure 1. Simplified interface of the test software complex.](image)

In this case, the employees of the company can:

- Examine the 3D model of the entire object;
- Examine map/aerial photography from the “top”;
- Perform various measurements;
- Examine measurements that occurred at the site over time, both discretely and in dynamics;
- Make comparisons between planned and actual production (by comparing reference models with actual ones at specific point in time);
- Examine attributive information by object;
- Mark/highlight/move objects.

Based on the list it is clear that the functionality described above is more than enough to ensure the maximum informational content for managers at the top and middle levels of the organization. In this case, the user receives a complete visually clear picture of the object in all possible angles and with all the necessary data (Figure 2).
This mode of operation provides the user with the following features:
1. It is easy, quick and intuitive to understand the operation of the software complex for a non-expert user;
2. Significantly facilitate the client of the program, thus making it possible to use Internet technologies and browsers to launch the application from any location that has access to the Internet without the need to download and install the software. This aspect indicates the possibility of cross platform application;
3. Restrict functionality for secure remote presentations and reports [6].

The following function modules are added to the professional program layout:
- creating and loading 3D models. This module supports all the main formats of 3D model programs (3Ds MAX, AutoCad, etc.);
  - editing attributive data. Editing is carried out by means of adding certain data on the object by clicking the right mouse button;
  - editing data. Both vector and raster data are edited. Besides, it can be used to vectorize scanned or photographed materials;
- working with the DB. It represents a form and query designer that allows not only populating the database, but also creating new tables for each individual object in particular and the project as a whole;
- performing calculations. Allows calculations of various kinds, such as orthophotriangulation, interpolation, data filtering, etc.;
  - modeling of motion of equipment and objects. This module is optional and is used to design automated control systems of facilities on site (excavators, cranes, and other systems);
  - automated monitoring and control. Currently, this module may not be used in mines, however, the development of efficient production is not possible without automated control systems. Such systems make it possible to significantly increase production and obtain more accurate real-time data on the state of the object;
- etc.

All of the above modules are connected to the core of the system only after their first call, provided that there is a client with data libraries installed in it. These modules allow using the functionality of...
geographic information systems and simple graphic editors in the application to coal sections of both open and closed types [5].

4. Conclusion
In conclusion, it should be noted that the approach to the construction of GIS systems described above can be implemented at other types of facilities (construction, oil and gas production, etc.). The introduction of next-generation GIS technologies will increase the efficiency of using databases and make systems available to a greater number of users, such as middle and senior managers. This will significantly increase their awareness and speed of making important decisions. It is worth noting the fact of obtaining data in real time, which is also beneficial for the object management system as a whole.

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