Easy-to-use customizable programming solution for integrated usage of different types of hydrogeological data and GIS layers

Dario Perković, Zoran Nakič & Jelena Parlov

Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb,
Pierottijeva 6, 10000 Zagreb, Croatia;
E-mail: *dperko@rgn.hr*, *znakic@rgn.hr*
jlukacev@rgn.hr

Abstract: A new approach is proposed to recording of the groundwater data and knowledge. The program solution uses GIS technology, relational database, and graphical and textual documents in a user-friendly way, by making the access to data from other applications is within a single central application.

Key words: hydrogeological objects, database, GIS, map control, hyperlink

Introduction

After the data resulting from hydrogeological research have been collected for a number of years, a conclusion was brought that the complete information content of an ample hydrogeological project could be improved by creation of a strictly targeted interface, or a special program shell. The user program shell is a specifically developed program solution that facilitates work with a more complex information system. The program shell is useful for accessing the data from a number of program packages integrated in a single central application. Most users today need an information system for loading and searching the data and for their handling and updating in both graphical and nongraphical formats. Generally, such users do not want to loose their time on dealing with technical details of the database or with voluminous manuals on software for management of the geographical information systems (GIS). A smaller group of users works with complex program tools for hydrological and hydrogeological modeling, spatial and statistical analysis, computer aided design (CAD), 3D modeling, and the like. Graphical programs for computer aided design have many secrets and hide numerous shortcuts that accelerate standard operations with the graphical data, and the relational database management systems can be linked with the CAD software through program modules, while the interface in GIS packages can be completely tailored to our needs. Therefore, if we want to resolve almost all of our problems using the off-the-shelf programs, we should use algorithms to create program modules that upgrade the existing applications. The program shell is developed by using the GIS methods and modules of specific professional software. Such user shell is a link between the hydrogeological database and other program applications.

Scientific paper

RESULTS AND DISCUSSION

Preparatory stage consisted in registration of numerous relevant objects, numerous data related to the hydrogeological systems and appurtenant groundwater, and preparation of a summary presentation of acquired knowledge on hydrogeological systems and inclusive water areas, up to the level of large well fields and groundwater spring areas. To meet the project requirements, which principally refer to smooth operation of the information system, a program shell was designed consisting of a grid of interconnected program packages with adequate user interfaces. The shell basis includes the program packages generally available to the professional community, i.e. *Access* as the database management software, *MicroStation* as the CAD tool and *ArcView* as the GIS browser and integrator of data that create a specific thematic unit. Another shell level includes the user programs such as *Visual ModFlow* for numerical simulations, *Statistica* and *Excel* for mathematical and statistical data processing, *ArcView Spatial Analyst* for spatial analysis, etc. Separate group of program packages includes the multimedia browsers: *PowerPoint*, *MediaPlayer*, and *IrfanViewer*. Special attention was paid to the database set. The geographical information system that contains the groundwater data has a complex set of data of different types and sorts related to the same geographical location. Thus, the following types of data exist for the same location (actually a well): drilling data, construction data, borehole testing data, system lithological texture data, deposit stratigraphic age data, data on hydrogeological characteristics of a system, data on water chemistry and level. Since each data set and its components are used separately for different interpretations, the database needed to be adequately organized and normalized[1].

In addition to browsing such databases with built in options, all data within the system may be accessed from hypertextual fields and *ActiveX* controls. The complete system is accompanied by adequate database models and metadata. The program shell is significantly improved by integration of nongraphical structural data and GIS layers by using *VBA* module and programmable *ActiveX map control* of *MapObjects*[2]. Integration within a shell (Figure 1) makes different data accessible:

- database tables
  1. long-term measurements of the groundwater tables in Excel (hyperlink)
  2. GIS projects in ArcView (hyperlink) (Figure 2)
  3. components of chemical analyses carried out in observation wells (hyperlink)
- groundwater systems knowledge base (document preview application) (Figure 3)
- literature used for acquisition of data on hydrogeological objects (table)
- slideshow presentations (database macros)
- audio-video aminations (database macros)
- digital camera images (database macros)
- satellite images (database macros)
- sorting objects by map sheets (VBA module)
- GIS & DBMS integration (ActiveX control of MapObjects) (Figures 4 and 5)
- geotransformer of object coordinates (VBA module)

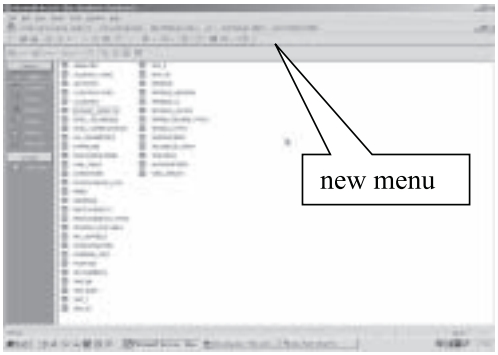

Figure 1. New menu in Access

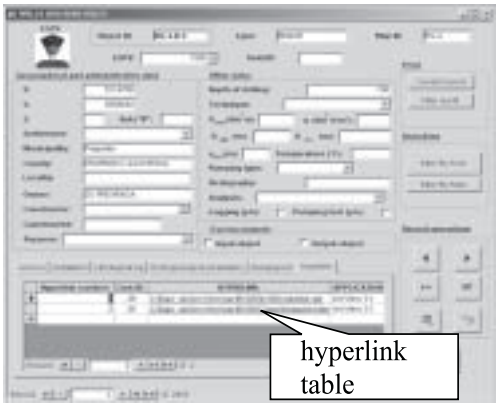

Figure 2. Hypertextual field for display of data from other applications

Figure 3. Visual Basic application for fast search of textual documents

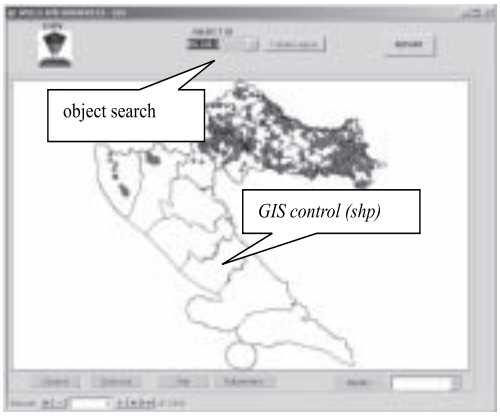

Figure 4. Searching objects and display on vectorized GIS (shp) layers

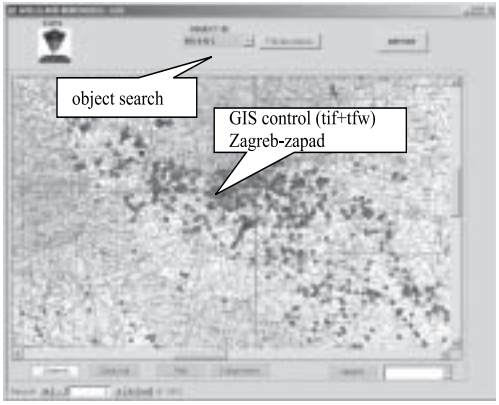

Figure 5. Searching objects and display on scanned GIS (tif+tfw) layer

This paper is intended to encourage use of various types/sorts of data and make the program more user-friendly for new users, new staff working on the project and management. Since the shell was created, additional options include:

1. integration of scanned georeferenced layers (layers with coordinates) and vectorized layers with database in Access
2. searching objects on a map by object/key selected from nongraphical base/table
3. browsing graphical layers (shapefiles) within GIS control in Access and retrieving information stored in attribute table
4. accessing contents related to the object or item by starting corresponding applications within the shell using HTTP protocol (hyperlinks)
5. previewing multimedia contents (slideshow, animation with instructions for use of GIS projects, digital image basis, etc.)
6. starting the knowledge base use application from the shell
7. performing automatic geoconversion of land surveying into mathematical coordinates
8. obtaining of integrated nongraphical/graphical printouts requested by today's users in format of a multipage report (basic data, technical data on bored structure installation, lithology, map section of scanned/vectorized map with object location.

CONCLUSIONS

The program shell may be used to access any information on a particular area or object, from all available digital contents (knowledge base, structured nongraphical database, graphical database, GIS database, …). In addition to technical (program) improvements in data use, the users have added the following characteristics of the program shell:

- preservation of the basic project principles and its information system, i.e. efficient use of easily accessible hardware and software resources,
- simplification, transparency and easier maintenance and use all databases from the program shell and targeted use of the existing or programmed interfaces,
- integrated screen display of data from different tables, graphical displays, diagrams and graphical layers that significantly facilitate use and interoperation of data from different individual databases,
- obtaining an information system that is highly user-friendly for an actual user,
- complex printout from the Access database in the form of reports that integrate all available textual and graphical data on an object, with the object location on a map and indication of possible interconnection with other applications.

REFERENCES

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[2]ESRI (1999): *MapObjects Programmer's Reference*, Redlands, CA, 580 p.