Sborník vědeckých prací Vysoké školy báňské - Technické univerzity Ostrava
číslo 2, rok 2007, ročník LIII, řada strojní
článek č. 1553

Robert KLIMUNDA[*], Martin KIJONKA[**]

THE UTILIZATION OF MODERN TECHNOLOGIES IN HMI SYSTEMS

VYUŽITÍ MODERNÍCH TECHNOLOGIÍ V HMI SYSTÉMECH

Abstract

In former times, HMI systems were conceived as closed systems extendable merely by means of modules of the manufacturer of the given system. At present, such software is, however, available prevailingly as open. This makes it possible to utilize even technologies that are primarily used in other areas. Universal databases, web servers, open data transmission protocols, and others can be given as an example. The objective of the contribution is to show existing possibilities of utilizing these elements in HMI systems, above all with emphasis on work with three-dimensional data.

Abstrakt

HMI systémy v dřívějších dobách byly koncipovány jako uzavřené systémy, které byly rozšiřitelné pouze pomocí modulů výrobce daného systému. Dnes je však tento software k dispozici převážně jako otevřený. To dovoluje využít i technologie, které se primárně používají v jiných oblastech. Příkladem mohou být univerzální databáze, webové servery, otevřené přenosové protokoly, atd. Cílem příspěvku je ukázat současné možnosti využití těchto prvků v HMI systémech, zejména se zaměřuje na práci s trojrozměrnými daty.

1 INTRODUCTION

Generally, in former times information systems were conceived as systems that served only the purposes for which they had been designed. Mostly, whatever vision of extending owing to growth or changes in organization as well as of a possibility of interconnection with other systems, e.g. to utilize more the data acquired, was missing here. The situation of HMI systems was similar.

At present, another situation exists in the software area; the existing trend is to utilize as many as possible universal modules, protocols and standards. This leads to making a lot of activities more efficient. First of all, this is a case of development of software concerned; by using e.g. universal database systems a proper solution, the development of which would be more expensive, may be replaced. But it is also favourable to software users. Those have a possibility of extending the solution already purchased not only to products of the same manufacturer.

The present-day HMI systems keep this trend. They are utilized by modern component technologies; a movement towards scalability and adaptability to a specific employment is observed here. The utilization of open and generally used technology standards (ODBC, OPC, .NET, XML, ActiveX, TCP/IP, and others) is an example. The utilization of Internet as a tool for distributing visualization to a lot of users is of importance too. Some of these technologies will be discussed in the following parts of this article.

[*] Ing., Institute of Economics and Control Systems, Faculty of Mining and Geology, VSB - Technical University of Ostrava, 17. listopadu 15, Ostrava, tel. (+420) 59 732 4446, e-mail robert.klimunda@vsb.cz
[**] Ing., Institute of Economics and Control Systems, Faculty of Mining and Geology, VSB - Technical University of Ostrava, 17. listopadu 15, Ostrava, tel. (+420) 59 732 4449, e-mail martin.kijonka@vsb.cz

2 MODERN STANDARDS FOR WEB GRAPHICS GENERATED BY HMI SYSTEMS

By means of Internet the existing HMI systems make it possible to provide visualization to a wide range of interested users who can utilize the visualized data. For display, so-called thin clients or web browsers are used. One of possibilities is using the dynamic web pages, for the generation of which functions summarily designated as DHTML that do not utilize plug-in modules, such as Flash, Java, ActiveX, etc., are used. This is a case of combination of functions that are provided by e.g. HTML, CSS, Document Object Model and JavaScript. Another element improving the openness and the transparency of data transferred is the utilization of XML. This is an open standardized markup language that becomes, thanks to its high information content, lucidity and portability, increasingly used not only in the area of web applications.

Companies developing Internet browsers and also organizations being concerned with web standards are aware of insufficiency in the area of web graphics, and that is why they bring improvements that move solving the given problems forward. One of them is support to the SVG (Scalable Vector Graphics) format [8], which is a format for animated and interactive 2D graphics designed especially for easy integration with the Web. It is an open vector format that has a chance of becoming a standard part of web browsers in the future. Nowadays, merely some browsers support it; with some a supplementary module supporting this format must be installed, some browsers support it by no means. In the future, the situation should change, and it will be possible to utilize the properties also in industrial visualization.

2.1 Utilization of ActiveX elements for 3D display in HMI systems

ActiveX control elements are software components that make it possible to enhance the functionality of various applications. These elements have been developed especially for web browsers to which they offer much better possibilities of displaying web pages in comparison with the classical HTML format. They are employed in the creation of dynamic presentations and elements, which would not otherwise be, by means of standard functions of browsers and their formats, available [1].

However, these elements can also be used today in other applications; software manufacturers implement the given solution in their products to extend their functionalities. As well, HMI software manufacturers accede to this solution. As an example of such software, a HMI system Promotic can be stated [7]. Developers of applications in this system have a possibility of inserting ActiveX elements, by means of which functions and displays that are in the given system otherwise unrealizable can be realized.

The given solution is typically used on Internet pages that at present make it possible to display three-dimensional objects, such as mobile phones. By means of a mouse and a keyboard the visitor to the web page is able to see the phone from all sides, to look at details, or is able to try to control it virtually. It is possible to use just this principle in the case of HMI visualization. What is a disadvantage of this solution is dependence on a certain type of browser.

In our specific case, we are concerned with the visualization of an underground mine. Of underground mines the spatial lay-out of passages and shafts is characteristic; they are not located on the same level but they are there at various depths below surface. Passages are not situated in individual layers, but they may even make various angles with the surface. Therefore, the mine is solved as a fully three-dimensional problem. That is why it would be suitable for operators to have a dynamic view of the whole observed area in a 3D image at their disposal.

For the solution of this problem proposed by us we selected Cult3D, i.e. an ActiveX element of Swedish company Cycore Systems AB [2]. This makes it possible to display 3D objects or scenes inserted into other applications. It is possible to move these objects, to turn them around the vertical

and the horizontal axis, to make the objects larger or smaller, and to put/ locate interactive elements into them.

This ActiveX element can be inserted into the application design in the visualization system Promotic, where the display of 3D scene is possible. This scene is designed in software Map3D, which enables the modelling of three-dimensional objects and scenes. The scene modelled by us represents the mine working that can be seen in Fig. 1.

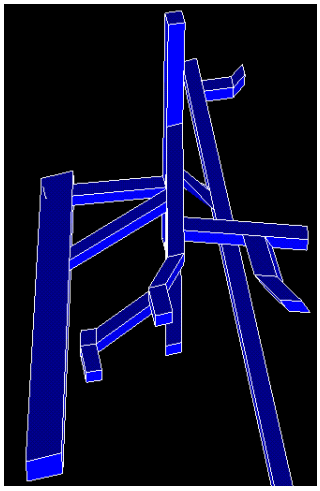

Fig.1 Mine system model

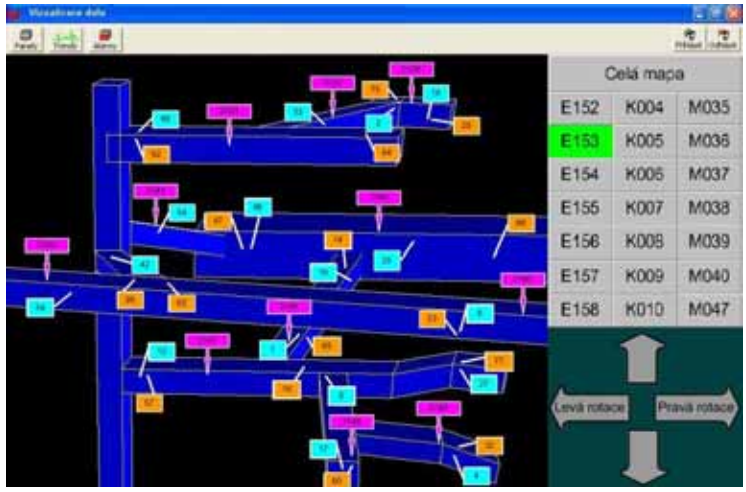

Fig.2 3D display of mine system in Promotic HMI software

The scene created is then exported into a format that can e displayed in Cult3D. After that the scene is read in the ActiveX element that is inserted in the visualization screen in the system Promotic. The final solution is there in Fig. 2. This solution may be advantageously used for the visualization by means of thin clients as well; in Fig.3 we can see the final scene in the Internet Explorer browser.

3 RAPID AND RELIABLE COMMUNICATION

Visualization systems as part of a business information system must have communication mechanisms at their disposal that will enable rapid and safe communication. Although interfaces used already for a long time, such as DDE or NetDDE, are easy to use and are supported even by older software products, they have a disadvantage, namely the low rate of reliability. Other interfaces removing this disadvantage are available, but they are interfaces more or less closed (such as SuiteLink from the Wonderware company).

That is why communication is heading towards the open standards. They will ensure the multi-system and multi-platform communication that will be rapid and reliable. One of protocols used commonly at present is a TCP protocol, which represents a transport layer in communication. The protocol guarantees reliable delivery and in-order delivery. TCP also distinguishes data for multiple, concurrent applications (for example, Web server of visualization and e-mail server) running on the same computer. A specific problem of this protocol is, however, its real-time application, because if one packet is lost the application cannot obtain following packets until the packet lost is sent again and received successfully. This deficiency can be thus problematic in a large number of applications of visualization systems.

For this reason, the utilization of protocols, which are defined by independent organizations or consortia and which are open and provide properties required for the use in the area of HMI system communication, seems to be a solution. The overall list of possible protocols and their specific properties would be beyond the scope of this contribution, and thus we mention only one of them.

The Stream Control Transmission Protocol (SCTP) is a transport layer that brings several channels independent of each other that are transmitted parallelly. Just this is probably the greatest difference from the existing transmission protocols. After connection is established, many data flows independent of each other can be transmitted via it. In the framework of each of them, SCTP is able to guarantee the delivery of all data in the correct order. A potential failure in some of the flows does not affect the other flows in any way. Their communication continues without interruption.

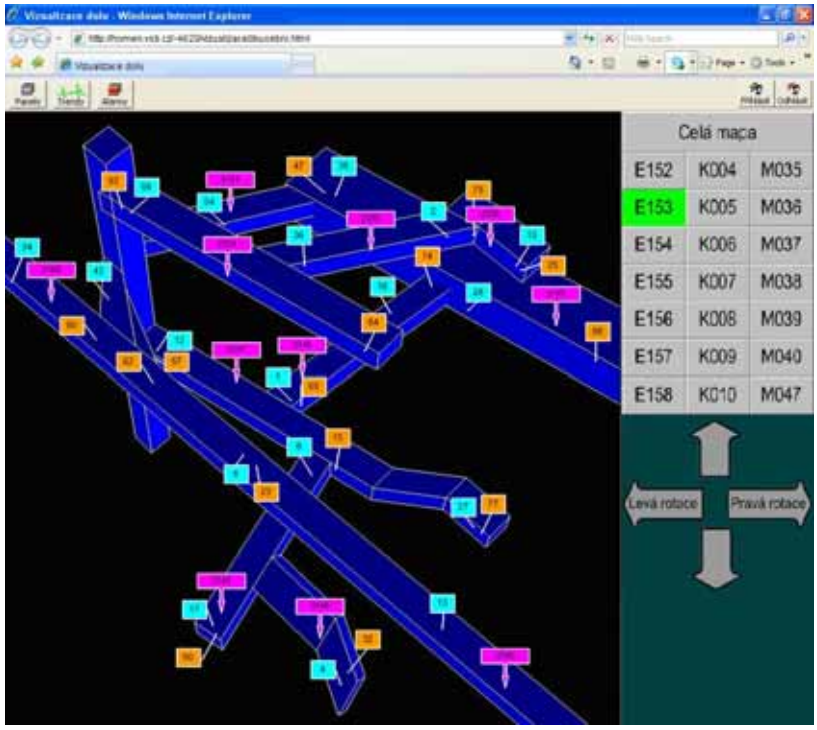

Fig.3 3D display of mine system in Internet Explorer

Naturally, it is also necessary to solve problems of link, network and application layers of communication protocols. What remains to be an issue is the enforcing of such standards in practice; the situation is similar to that in the communication of control systems on the lowest level of control, where a large number of noncompatible communication solutions are always available (although here, a trend towards unification is evident).

4 SPATIAL DATA IN THE HMI SYSTEMS

Visualization systems utilize primarily their own integrated databases of variables, in which measured values from sensors, etc. are stored, for data storage. The storage rate and the reading rate, reliability, and others are of importance to work. At present, these internal databases have not standardly integrated data types for storing data of another type. For storing a large amount of values and data, communication with standard universally used database systems is prepared, or manufacturers supply their own database systems designed for storing a large amount of data from industrial environment [6].

5.1 Spatial Data Storage

In a case of database systems supporting the spatial data, tables for attribute and geometric data are typically earmarked. The attributes are stored in a table that is interconnected with a so-called geometry table, in which the geometry of elements is stored. Spatial information on elements is

in this case stored either as binary data or as numeric data (elements are stored as coordinate chains). In the other case, i.e. with using spatial data types, the table of attributes of elements uses one column for storing the geometry of the elements.

Systems supporting the storing of geodata use merely one table for the storage of one element class. In its spatial column, the geometry of elements is directly stored as spatial data type that is supported by the given system. These formats are based above all on the OGC or SQL/MM Spatial standards, but they are different for example in data types, dimensions of objects, added methods, etc. To store spatial data in the systems that implicitly do not support spatial data, software manufacturers offer various upgrades and modules, so-called middleware, making it possible to work with these database systems.

5.2 Database Systems and Their Support for Spatial Data Types

Top manufacturers of database systems implement support for this data either directly in the systems or provide available extending modules to be used. The extent of this support depends on a specific manufacturer of the system. All systems described below use the specifications of OGC - Open GIS Consortium, Inc, which is an organization concerned with standardization in this area [9], as a basis.

One of the biggest manufacturers of databases is the company Oracle, which offers an Oracle Spatial upgrade to its primary database product. This upgrade provides SQL schemas and functions that enable work with spatial objects. The given schema has built-in support for the following data types: point, line chain, polygon, chain of curves, curve polygon, combined polygon, lines and curves, circles, and rectangle. Over them a large number of functions, indexing and others are defined. The coordination system itself is another necessary part of this upgrade. In Oracle Spatial support for several coordination systems is built. For effective search and query creation, an indexing system is available, more specifically so-called R-Tree indexing. This enables indexing in up to four dimensions. The basis of indexing is the creation of element envelopes (rectangles the edges of which embrace the whole element from four sides); these envelopes are created on several size levels and all envelopes are as a whole incorporated into the tree structure.

To the DB2 database product, the company IBM also supplies an upgrade Spatial Extender for spatial data. This tool works with spatial objects in a way similar to that of the previous product. To the database product PostgreSQL the organization Refractions Research developed an upgrade PostGIS. In contrast to the previous products, this is a case of open-source software. The authors themselves compare the functionality of it to that of e.g. Oracle Spatial. For indexing, this upgrade uses the R-tree spatial index. PostGIS also contains extending data types exceeding the OGC specifications. What is meant is a type enabling the storage of 2.5-D elements (containing the Z-coordinate) and dynamically segmented elements (elements of M-values). In a case of MySQL, support for spatial data types is already standardly built in; partly it also corresponds to the OGC specifications. For indexing, the R-tree spatial index is used again.

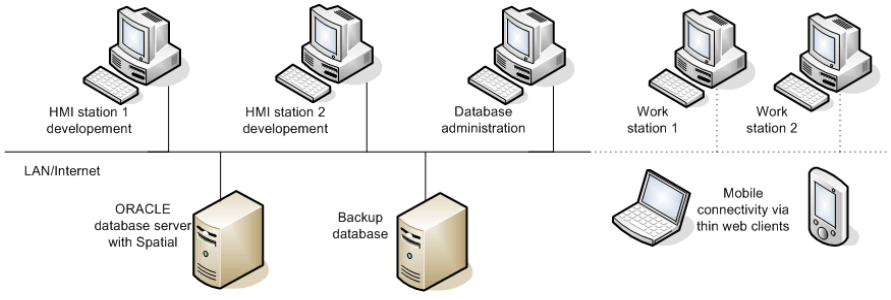

Fig.4 Solution structure with Oracle Spatial server

As for our specific problem – the storage of data from the mine system, what is a decisive criterion for the selection of database system is support provided to work with spatial objects. We chose the Spatial upgrade to the database system Oracle supporting work with 3D objects. The structure of our solution with this system is shown in Fig.4.

Here, we can see a server part, where the database system Oracle with the Spatial upgrade is available; it is designed for data storing and sharing as required. To it clients working on the development of the client part of application or users already utilizing the application for monitoring purposes can connect independently. Thanks to the utilization of native properties of databases, the independent and simultaneous access of a large number of users, data security (assignation of specific authorization to individual users for data management), data back-up, and others will be ensured.

5 CONCLUSION

In the contribution we tried to point out the present possibilities of utilizing software elements and technologies in HMI visualization systems. The existing trends in information systems lead to the openness and the utilization of component technologies. Solutions making it possible to enhance the functionality of visualization systems with new properties relatively quickly and simply are available. This is utilized by developers of these systems and also by system integrators. The above-mentioned solutions show in more detail some possibilities of utilizing the already existing solutions especially in the course of work with spatial data. Of course, other possibilities may be found, but the analysis of them would be beyond the scope of this article.

REFERENCES

[1] *ActiveX Controls. Microsoft*. [online]. Microsoft Corporation, Redmond, WA, August 20.2007, [cit. 6.10.2007]. Available from www: <URL http://msdn2.microsoft.com>.

[2] *Cult3D. Cycore Systems AB*. [online]. Cycore Systems AB, Uppsala, Sweden, 09.03.2007, [cit. 5.10.2007]. Available from www: <URL http://www.cult3d.com>.

[3] KLIMUNDA, R; KIJONKA, M & ŠIMEK, R. *Remote data visualization in computer networks.* 8 th International Carpathian Control Conference, Štrbské Pleso, High Tatras, Slovak Republic, Košice, Slovensko, TU v Košiciach, 2007. ISBN 978-80-8073-805-1.

[4] KODYM, O. *Využití virtuální reality pro rozvoj oboru HGF*. Habilitační práce VŠB-TU Ostrava, 2005.

[5] *Map3D. Mine Modelling Pty*. [online] Corporation , Mt. Eliza, Victoria, Australia, 6.10.2007, [cit. 22.10.2007]. Available from www: <URL: http://www.map3d.com>.

[6] NEUSTUPA, Z. *Aplikace informačních technologií pro modelování a tvorbu krajiny po hornické činnosti*. Habilitační práce VŠB-TU Ostrava., 2006.

[7] PAPEŽ, J. *Promotic-internetové aplikace snadno a rychle*. Automatizace. 2005, ročník 48, číslo 1, pp.29.

[8] SPIEGEL, R. *Web Technologies, watching your plant from anywhere*. 2004 [online] Summit Media, LLC , Chicago, Illinois, June 2004, [10.10.2007]. Available from www: <URL http://www.automationworld.com/view-707>.

[9] *The Open Geospatial Consortium* [online] Open Geospatial Consortium, Inc. , international voluntary consensus standards organization, 4.10.2007, [cit. 5.10.2007]. Available from www: <URL: http://www.opengeospatial.org>.

Reviewer: prof. Ing. Radim Farana, CSc., VŠB - Technical University of Ostrava