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INTERNET PORTAL OF GEOPHYSICAL MONITORING

The prototype of developed geophysical Internet portal as subsystem of software of geodynamic monitoring data acquisition and processing is presented. The prototype is based on database management system *MySQL* and it can be placed both on their own servers of an awarding authority (in this case – the Carpathian Branch of Subbotin name Institute of Geophysics of NAS of Ukraine) and on public Internet servers. Interaction of database and client modules within the bounds of this software is described.

Key words: geodynamic monitoring, data acquisition system, database, data processing.

Introduction

Current monitoring of natural and technological geodynamic processes is very important problem of humanity. In this regard it's enough to recall the disastrous consequences of the last few strongest world earthquakes - Sumatran (2004-2005), China (2008), the Haitian and Chilean (2010), Japan (2011). Now such monitoring cannot be imagined without the use of computer and Internet technologies. They are used in intellectual measuring geophysical systems, local systems of data collecting and transmitting, in regional and global centers of collection and processing monitored information [1-5].

In this article the applications features of computer and Internet technologies in creation of Internet portal of geophysical monitoring data processing are shown.

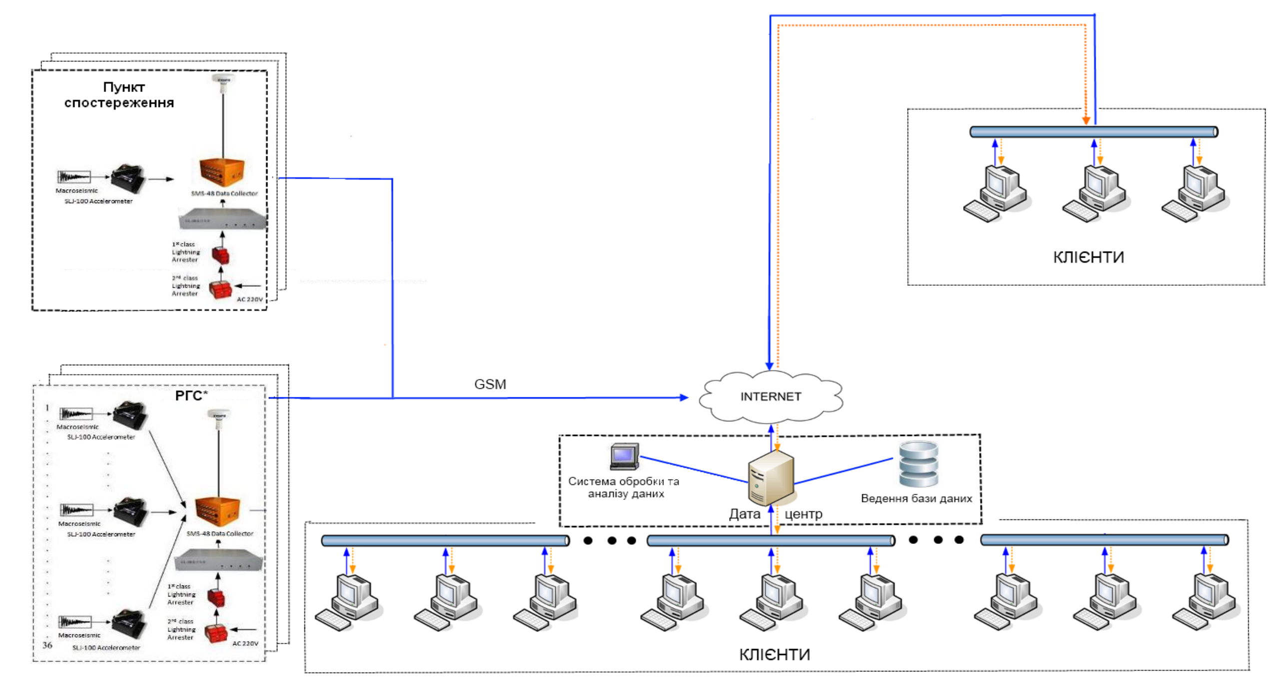
Initial data

Seismoprohnostic researches in the World have been conducted for over 50 years [6, 7]. Employees of Carpathian Branch of Subbotin name Institute of Geophysics of NAS of Ukraine for over 30 years conduct monitoring seismoprohnostic geophysical surveys in Transcarpathians [8-18]. These studies are conducted using various geophysical methods in the network of regime geophysical stations (RGS) and observation points. The digital geophysical equipment currently works in RGS and observation points. Monitored data are stored in Web server and periodically are delivered to Lviv for processing and analysis. With the expansion in recent of the Internet availability there was a task to use it for quick transfer of data from observation points to the created regional geophysical information center. It is reasonable to solve complex problems of transmitting data between points, archiving it in a database, process and analyze. The tasks were set in creating of the Internet portal of geophysical monitoring data processing.

The general structure and algorithm of Internet portal

The general block diagram of a geophysical data processing Internet portal (Fig. 1) consists of a network of RGS (which are local systems of data collection and processing) and geophysical observations points. They all are related to the regional information center (data center) by Internet**.** There are main server, database server, administration module and local users in data center. Also a remote client access to the server and database via the Internet is provided.

To create geodynamic monitoring data processing Internet portal the Java programming language was used. Internet portal was created as an interactive Web page that can be placed on the own server of the company-customer (Carpathian Branch of Subbotin name Institute of Geophysics of NAS of Ukraine (as in Fig. 1)) or on the public internet servers. Functionally the software complex consists of the following modules: receiving module of geophysical information, database communication module, client modules, system administrator module.



*РГС – regime geophysical stations (RGS)

Fig. 1. Structural scheme of geophysical data processing internet-portal.

Receiver module receives geophysical information from observations posts using Internet. Connectivity module with database provides support of geophysical database in which geophysical data is bonded to date, observation post and geophysical method (data source is geophysical hardware system). Client module provides searching and reviewing collected data graphically and also provides downloading data to the user PC (depends on the user access level). Administrator module provides full system administration.

<u>Analysis information flows and portal requirements.</u>

On the prototype stage internet portal software should solve task of processing geophysical data in particular inputting data from input buffer (data is put there by receiver module) to database and this data can be fetched by client (considered to user access level) for further review and processing. For example on pic. 2 the format of input file with geothermic data is given.

Fig. 2. Format of input file with geothermic data

One of the key tasks during system development is creating and maintaining geophysical monitoring database (is showed here on geothermic data example). Client and server parts of Web portal system are based on the database structure

Database should support data saving with bound to:

- Observation post;
- Apparatus type;
- Chanel number;
- Date and time.

In case when data flow is the heaviest (except seismic-channels and special modes for geo-acoustic, infrasonic, inclination measuring and couple others), when data from geophysical apparatus came every second we have following amount of data (it is for case when we give 10 signs (5bytes) for each measure):

Amounts of geophysical data for different measuring frequencies

Measuring frequencies	1 second		10 second		1 minute	
Time interval	Amount of data		Amount of data		Amount of data	
	value	Bytes	Value	Bytes	Value	bytes
Hour	3600	18000	360	1800	60	300
Day and night	86400	432000	8640	43200	1440	7200
Month	2592000	12,1 mln.	259200	1,21 mln.	43200	216000
Year	31 mln	155 mln.	3,1 mln	15,5 mln.	518400	2,59 mln.

MySQL is used as RDBMS. The reason of this decision is that chosen DB support maximal amount of rows in each table up to 50 million that means that with maximal data flow (data in table) received data is advisable to combine in year tables. For further optimization of these tables we have provided monthly partitioning feature.

Considering the maximum possible amount of data which could be stored in *MySQL* 3.23+ it is 8 millions of terabytes (2^{63}), it goes without saying that this data limit is more than enough for storing our system data.

We were developing our Internet portal in example of geothermal data processing. The measurement interval is 10 seconds and the maximum annual amount of data is 3.1 million values.

There is 2 data saving formats: direct (10 digits) and floating-point (6 digits – mantissa and 4 digits - exponent).

The database must support the standard SQL queries of 2003 for carrying out sample data by required parameters.

The optimization ways of database structure and formats of the data in it are not considered. These questions will be developed in the future by putting into database real data from the observation points with different geophysical equipment.

The hardware and software requirements.

Hardware and software requirements for Web portal are not high because the selected software is ported to a large number of platforms (AIX, BSDi, FreeBSD, HP-UX, Linux, Mac OS X, NetBSD, OpenBSD, OS/2 Warp, SGI IRIX, Solaris, SunOS, SCO OpenServer,SCO UnixWare, Tru64, Windows 95, Windows 98, Windows NT, Windows 2000, Windows XP, Windows Server 2003, WinCE, Windows Vista and Windows 7).

The minimum hardware requirements for Web portal server are follows:

- Processor: Pentium 3 or higher;
- RAM: 512 MB or more;
- Capacity of the hard drive: 80 GB or more;
- Peripherals: LAN 10 Mbps or faster, CD/DVD-ROM

For the same database it is reasonable to use 2 hard drives combined into RAID 1 array that will provide automatic data backup and high storage reliability. One of these drives can also be remote network data storage. It is rational to define capacity of these drives keeping in mind that geophysical data accumulation will be carried out not less than 10 years. Also increasing the number of observation points and a set of equipment in it are planned, so it may need a lot of disk capacity too.

Projecting of Internet portal

The general scheme of client and server modules work and interaction was developed, based on the above analysis (Fig. 3).

Programming tools.

As noted above, the system was designed by software as an interactive web page and for this Java programming language was used. It is choosed because it provides the necessary functionality, exactly:

- This language is object-oriented and it is convenient to make large and complex projects.
- Java is an over platform language and this allows us to install developed web portal on any hardware-software system for which the Java virtual machine exists (and it exists now for almost all platforms).

• In Java there are a lot of free libraries and open source software.

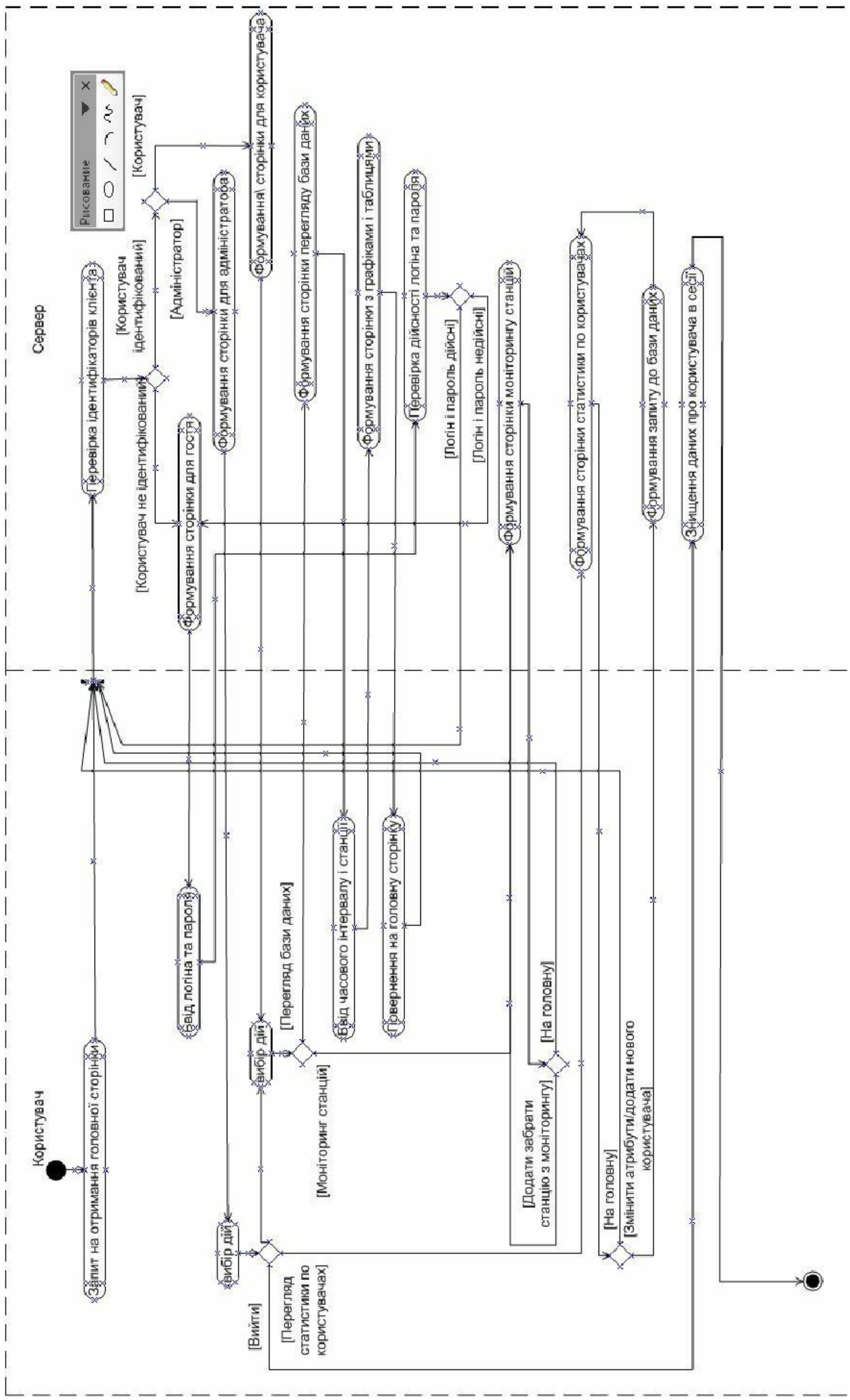


Fig. 3. Algorithm of geophysical Web portal client and server modules interaction.

Java virtual machine can automatically manage memory – this is one of the aspects that makes it easier to write programs. The following technologies were used in the development software:

• Java EE (Enterprise Edition) – a set of specifications and related documentation for Java, which describes the architecture of a server platform for the tasks of medium and large projects;

• JSP (Java server page) – a technology that allows web developers to generate dynamically HTML, XML and other web pages;

• Java Servlet – a standardized set of functions that create dynamic content for the web server with the use of Java platform.

Development of the product was carried out using the following environments:

• NetBeans 7.0 – environment of elaboration in Java language (advantage of this environment is the large number of tools and functions in the default installation options; it allows you to not install additional plugins for work; also as an advantage the servlet web server GlassFish 3.0 which is installed with the environment was presented).

• Eclipse 3.6 – environment of elaboration in Java language (advantage of this environment is great flexibility in setting up, a large number of applications and plug-ins that provide unlimited space for expansion of functions of the environment). The portability of environment is also an andvantage, it is not necessary to install, just enough to unpack once, configure and install the plug-ins and further this collection will continue to be run on any system of this type.

Supported architectures for Eclipse 3.6:

- AIX (PPC/Motif)
- FreeBSD (x86/GTK 2)
- HP-UX (HP9000/Motif)
- Linux (x86, x86-64, PPC, IA-64/GTK 2)
- Linux (x86/Motif) Mac OS X (x86, x86-64, PPC/ Cocoa)
- OpenSolaris (x86, x64, SPARC/ GTK 2)
- Solaris 8 (SPARC/GTK 2, Motif)
- Microsoft Windows (Win32, Win64)

As database management systems (DBMS) open source system MySQL [20, 21] was used. Now MySQL - one of the most common database management systems. It is used primarily to create dynamic Web pages because it has excellent support from a variety of programming languages for the Internet.

For non-commercial use MySQL is free. Features of the MySQL server as follows:

• easy to install and use;

• supports an unlimited number of users simultaneously working with the database;

• the number of rows in the tables can be up to 50 million;

• high speed of commands execution;

• the availability of simple and effective security system;

• support of transactions.

One of major components of created Web portal is servlet container Apache Tomcat. It is written in Java and implements the servlet specification and specification JavaServer Pages (JSP) which are the standard for developing of web applications in Java. Used by us Apache Tomcat has the following components: Jasper (redesigned mechanism JSP), Catalina (redesigned servlet container) and Coyote (stack HTTP).

Realization of components of Internet portal

Database communication module.

Based on the analysis of presented above requirements the structure of the database has been developed in which the data are divided into two major subsets.

The first subset is the users table, it saves the personal data of each user (Fig. 4.a):

• The user ID (UserID);

• Date of User Registration (UserRegData);

• User Login (UserLogin);

• User password (UserPass);

• User rights to access to system resources (UserAccesType);

• Date of user last login (LastLoginDate);

• IP address of last login (LastIPDate);

• The number of events in the system (LoginTimes);

• The last request sent by user (LastRequest);

• User name (UserName);

• User Surname (UserSurname);
• User Email (UserEmail);
• Additional user information (Additional_inf).

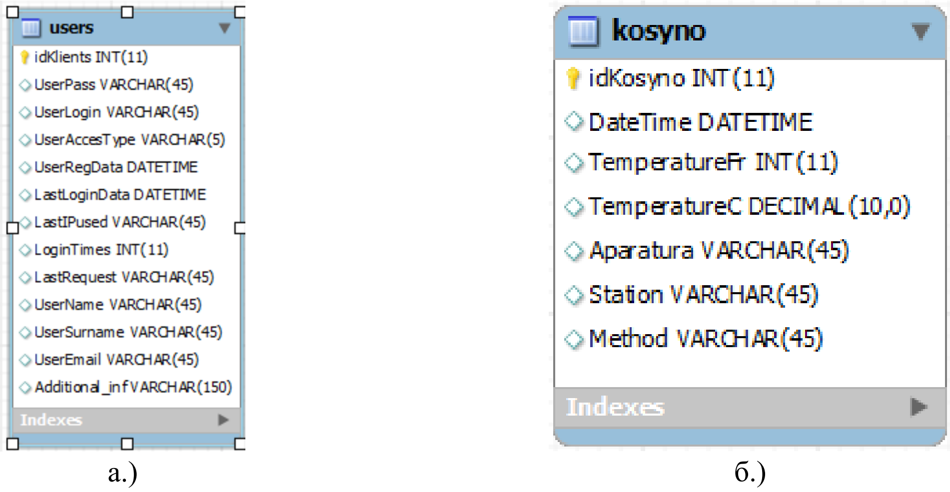


Fig. 4. User information table (a) and data table
(example of geothermal observation points "Kosyno") (b).

The second subset is the data tables, which contain observation points data. These tables have roughly the following structure (Fig. 4.b):
• Key;
• Station name;
• Geophysical methods;
• Hardware type;
• Channel type and number;
• Measurement date and time;
• Geophysical data.

Client module.

The module includes:
• User authentication system;
• System of selection and visualization geophysical data and forming them into a client file.

The task is particular to visualize the selected data in the form of graphs and charts. To do this the free libraries jfreecharts was used. Library provides functions for plotting graphs, charts and following their saving as graphics objects. Graphs and charts plotting is based on a collection of objects DefaultCategoryDataset.

The client module should have the user an intuitive and user-friendly interface to interact with the database and processing of geophysical data.

The main functions of the client module:
• Data visualization (display of graphs and numerical values etc.);
• Data correction in the database (according to the level of access);
• Create a file with the selected data to download to user computer.

There was created the interface for interaction with Web portal through which enquiries on the selection of data for visualization are formed.

When client module was developing, the library GWT (Google Web Toolkit) was used. This library allows to write the code in Java which is converted then to JavaScript and XML. After that it works using AJAX technology.

The following functions in client interface module was realised:
• Creating a table that displays data from stations;
• Creating control elements;
• Creating of browse list (stations, methods, equipment);
• Creating a service timestamps (protocol activity service).

Earlier developed utilities are also connected to this module. They are destined for conversion and geophysical data preprocessing [16-18]. This is particularly the utility «Converter-D». It works in Windows environment.

The functioning algorithm of the client module is shown in Fig. 5 and an example of his work is shown in Fig. 6.

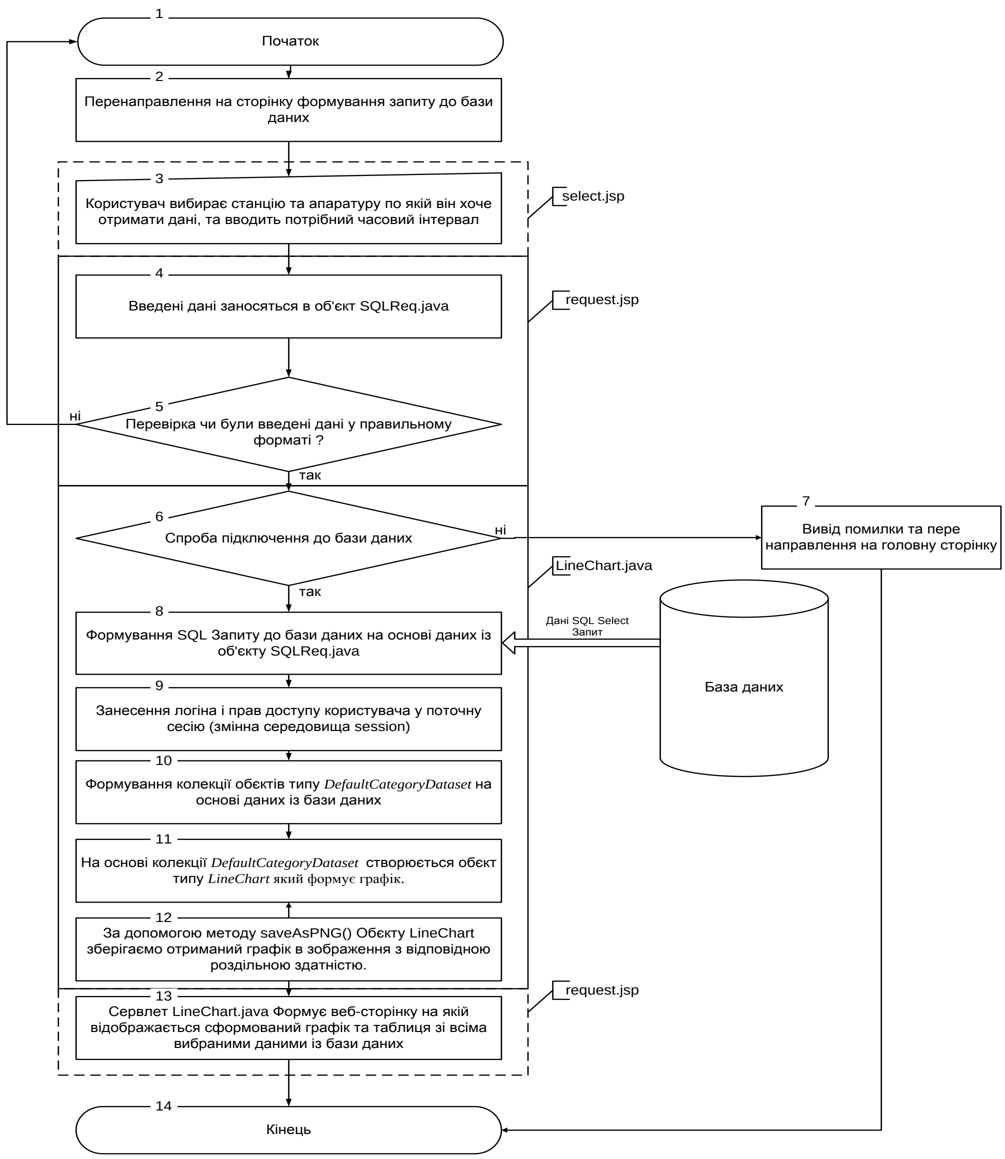
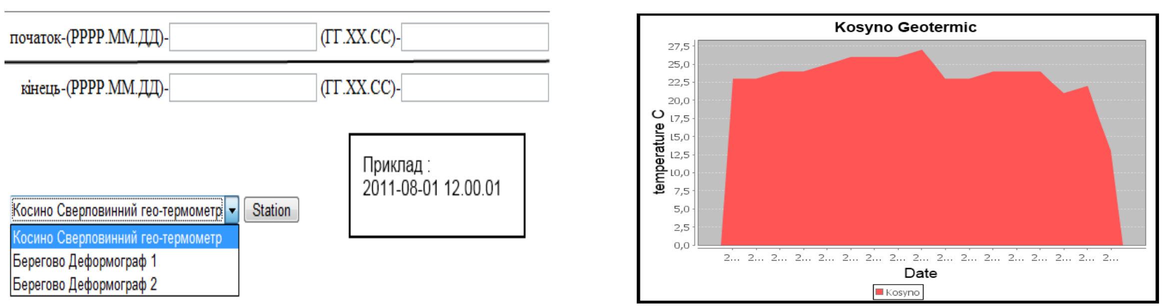


Fig. 5. The algorithm scheme of visualization systems functioning



a.) б.)

Fig. 6. Interactive client module interface: a) – database query forming page; b) -graphic visualization of temperature data from point "Kosyno" (for example, external temperature).

The client module also provides access to information in the database at two levels with differentiation by sublevels according to the results of user authentication (authentication algorithm for this is shown in Fig. 7).

<u>Access levels (client).</u>

The first level (**R1**) (guest) **-** access to data view (no editing).

The second level (**R2**) (user) - access to viewing, editing and processing.

<u>Access sublevels to:</u>

• Station at which measurements were carried out;

• Geophysical methods;

• Equipment.

Access Level **R0** - this is access level of server admin that provides access rights to control and modify the software.

Relating to further geophysical data processing and to requirements for the formation of files that should be issued by system at the request of the user, the corresponding examples are given, in particular, in articles [16-18], which show pretreatment (preprocessing) methods of extenzometric data using developed by our utility «Converter-D».

Testing of software.

Created prototype of geodynamic monitoring data processing Web portal had functional testing. It was conducted under a specially created test accounts on the example of geothermal data from point "Kosyno" which is one of the first in plans for connection to Internet. An example of a test query and graphical data output is shown in Fig. 7 and an example of testing of page of user authentication **-** in Fig. 8.

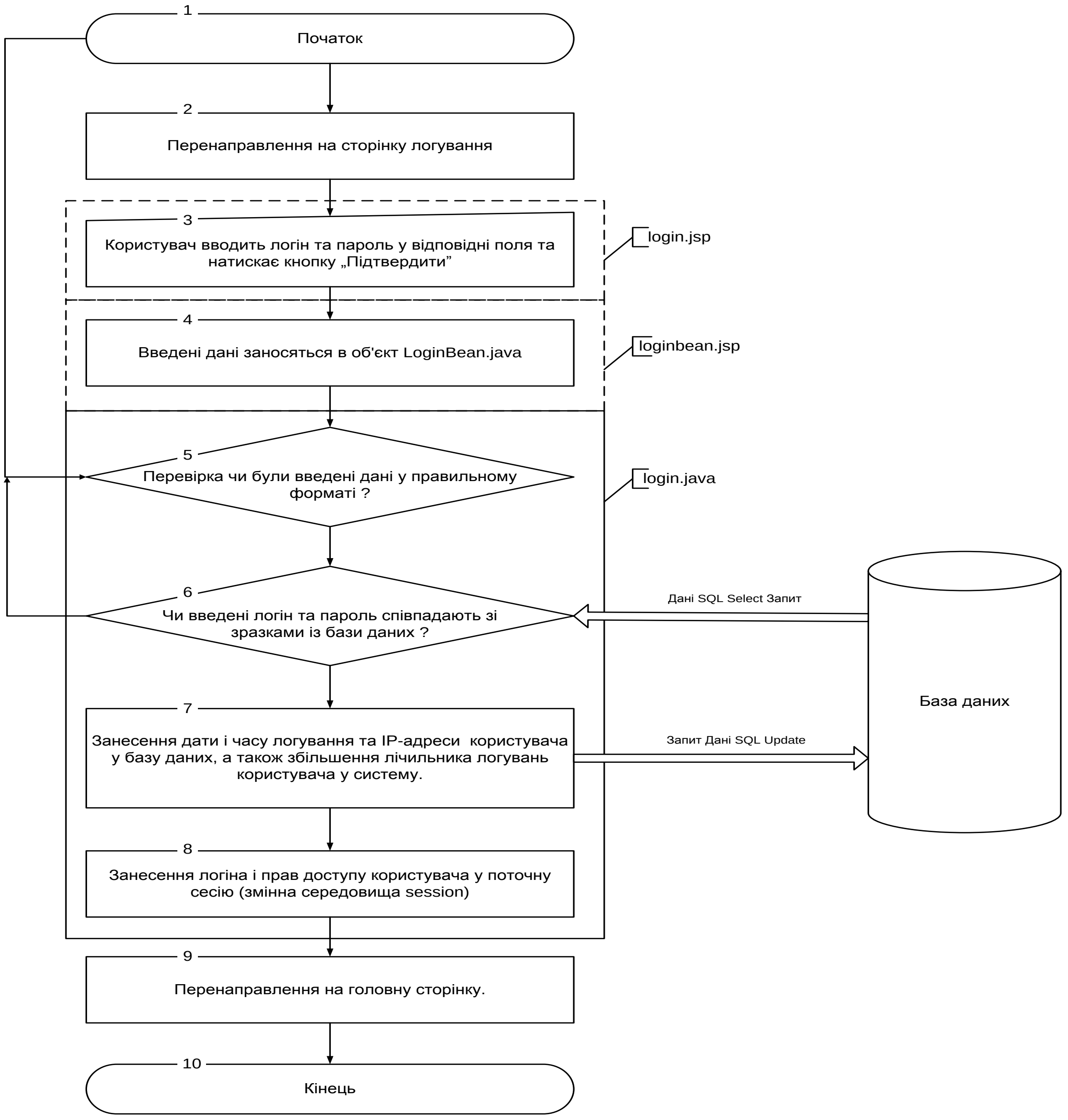


Fig. 7. The algorithm scheme of user authentication functioning

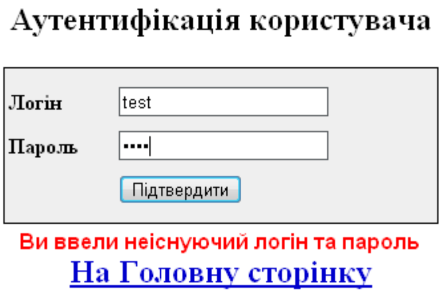


Fig. 8. User authentication test page.

Conclusions

Summing up we can state that created geophysical monitoring Web portal solves the assigned tasks and substantively functions. With the development Internet-equipped network of monitoring geophysical observations it can increase and be improved according to needs because it has the good flexibility and scalability.

1. Геофизическая служба Российской академии наук [електронний ресурс]: http://www.gsras.ru/ – 2014. 2. Global Network for the Forecasting of Earthquakes [електронний ресурс] http://seismonet.org/ – 2014. 3. European-Mediterranean Seismological Centre [електронний ресурс] http://www.emsc-csem.org/ – 2014. 4. Gravity time dependency research (Європейська мережа маятникових нахиломірних станцій) [електронний ресурс] http://www.dynamicgravity.org/ – 2014. 5. Шевчук Б.М., Задірака В.К., Гнатів Л.О., Фраєр С. Технологія багатофункціональної обробки і передачі інформації в моніторингових мережах. – К.: Наук. думка, 2010. – 368 с. 6. Рикитаке Т. Предсказание землетрясений. – М.: Мир, 1979. – 388 с. 7. Аранович З.И., Маламуд А.Я., Негребецкий С.А., Трапезников Н.Л. Метрология, принципы построения и функциональные особенности сейсмометрических регистрирующих систем / Автоматизация сбора и обработки сейсмологической информации. – М.: Радио и связь. – 1983. – С. 5-19. 8. Максимчук В.Ю., Кузнецова В.Г., Вербицкий Т.З. та ін. Дослідження сучасної геодинаміки Українських Карпат. – К: Наук. думка. – 2005. – 256 с. 9. Назаревич А.В. Автоматическая система передачи результатов геофизических наблюдений по линии электросвязи. // Современные геодинамические процессы и их изучение в связи с проблемой прогноза землетрясений. – К.: Наук. думка. – 1986. – С. 48-51. 10. Назаревич А.В. Автоматический цифровой геоакустический комплекс. // Сейсмопрогностические исследования на территории УССР. – К.: Наук. думка. – 1988. – С. 116-123. 11. Назаревич А.В. Оптимізація методико-апаратурного забезпечення мережі геодинамічних спостережень України // Праці НТШ. – Львів. – 1997. – С. 148-157. 12. Назаревич А., Назаревич Л. Оптоелектронний вимірювальний канал до кварцового деформографа / Геодинаміка. – 1999. – № 1(2). – С.116-120. 13. Назаревич А.В., Назаревич Л.Є., Баштевич М.В., Назаревич О.В., Микита А.Ю. Геоінформаційні технології в геомоніторингових дослідженнях // Геодезія, картографія і аерофотознімання. – 2003. – № 63. – С. 266-271. 14. Лящук Д.Н., Назаревич А.В., Назаревич Л.Є. Геоелектромагнітноемісійний метод в моніторинзі локальних геодинамічних процесів // Вісник КНУ ім. Т.Шевченка. Геологія. – 2003. – № 26-27. – С. 92-97. 15. Кендзера О., Вербицький Т., Вербицький С., Вербицький Ю. Цифровий сейсмограф для регіональних спостережень та результати його випробувань. –Геодинаміка. – 1998. – №1. – С. 120-126. 16. Назаревич А.В., Мицик Б.Г., Баштевич М.В., Назаревич Р.А. Деформографічні дослідження сейсмотектонічних процесів в Українському Закарпатті (геоінформаційні аспекти). IX International Conference "Geoinformatics – Theory and Applied Aspekts". 11-14 May 2010, Kyiv, Ukraine (CD). 17. Мицик Б.Г., Назаревич А.В., Баштевич М.В., Назаревич Р.А. Безконтактні ємнісні вимірювачі мікропереміщень у деформографічних геофізичних дослідженнях // Відбір і обробка інформації. – 2011. – Вип. 35 (111). – С. 69-76. 18. Назаревич Р., Мархивка В., Струк Є., Назаревич А. Конвертація та препроцесинг даних деформографічного моніторингу // Вісник НУ "ЛП" "Комп'ютерні науки та інформаційні технології". – Львів. – 2011. – № 694. – С. 334-340. 19. Turner James. MySQL and JSP Web applications. – Sams Publishing, 2002. – 560 с. 20. Маркин А.В. Построение запросов и программирование на SQL. – Рязань, 2008, – 312 с. 21. Jeffrey Richter. Programming Applications for Microsoft Windows – Microsoft Press, 2004. – 723 p.