SMGroup

SM Journal of Biomedical Engineering

Research Article

System Decision Support Based on Internet Technologies to Predict Control Living Systems

Rimma Alexandrovna Tomakova[1], Alexandra Nikolaevna Brezneva[2], Alexey Evgenievich Khanykov[1] and Vladislav Andreevich Alexeev[1]*

[1]*South-West state university, Russia*
[2]*Russian Economic University Plekhanov, Russia*

Article Information

Received date: Jul 02, 2018
Accepted date: Jul 16, 2018
Published date: Jul 19, 2018

***Corresponding author**

Vladislav Andreevich Alexeev, South-West State University, Kursk, Russia, Email: vladislaw.al2015@yandex.ru

Keywords Monitoring the effectiveness of therapeutic procedures; Internet technologies; Interior; Surrogate marker; Web service; Algorithm; Software

Abstract

The article considers algorithms and methods for constructing decision support systems for forecasting and controlling the effectiveness of living systems management, to ensure the effectiveness of therapeutic procedures (ETP). ETP control is implemented in three stages. At the first stage, surrogate markers are selected, through the monitoring of which a decision is made on ETP. At the second stage, a distributed database is created, which allows the creation of surrogate markers intended for ETP monitoring. At the third stage, a meta-analysis of the information collected in the distributed database on surrogate markers is made, which results in a decision on the ETP.

A web service is presented in which surrogate markers are selected based on analysis of intercellular relationships of peripheral blood smears. Algorithmic support of the web service and the structure of its software modules are given. The functional interaction of the developed software modules and the structure of the module for monitoring the dynamics of intercellular relations providing a meta-analysis of the effectiveness of drug prescriptions are described.

To ensure the functioning of the module for the analysis of the dynamics of intercellular relationships in the process of medicinal prescriptions, appropriate procedures for the analysis and classification of images of peripheral blood smears have been developed.

Introduction

Currently, modern healthcare is oriented towards the application of information and telecommunication technologies (ITT) for data collection and analysis, decision support [1,2].

The introduction of Internet technologies with the necessary tools for analyzing the large volume of physiological parameters of patients makes it possible to monitor the results of therapeutic procedures not only to the treating physician, but also to the patient himself. Intellectual technologies provide opportunities for identifying adverse reactions (AR) at a preclinical level or detecting individual incompatibilities of prescribed drugs; those implement technology "second medical opinion" [3-7].

At the same time, the solution of the problem of controlling the effectiveness of medicinal prescriptions is connected with the search for surrogate markers. It is believed that changes in these indicators during treatment should also affect a clinically significant outcome.

Materials and Methods: First, confirm that you have the correct template for your paper size. This template has been tailored for output on the US-letter paper size. If you are using A4-sized paper, please close this file and download the file "MSW_A4_format".

Maintaining the integrity of the specifications: The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations.

Materials and Methods

The main structural element of the proposed information technology is the "interior". The interior is a computer program that allows in an interactive mode to carry out experimental studies on meta-analysis of the effectiveness of control actions on living objects through Internet technologies. This program is intended for the decision-maker (DM), therefore contains tools for meta-analysis. Figure 1 shows the structure of the interior and its purpose.

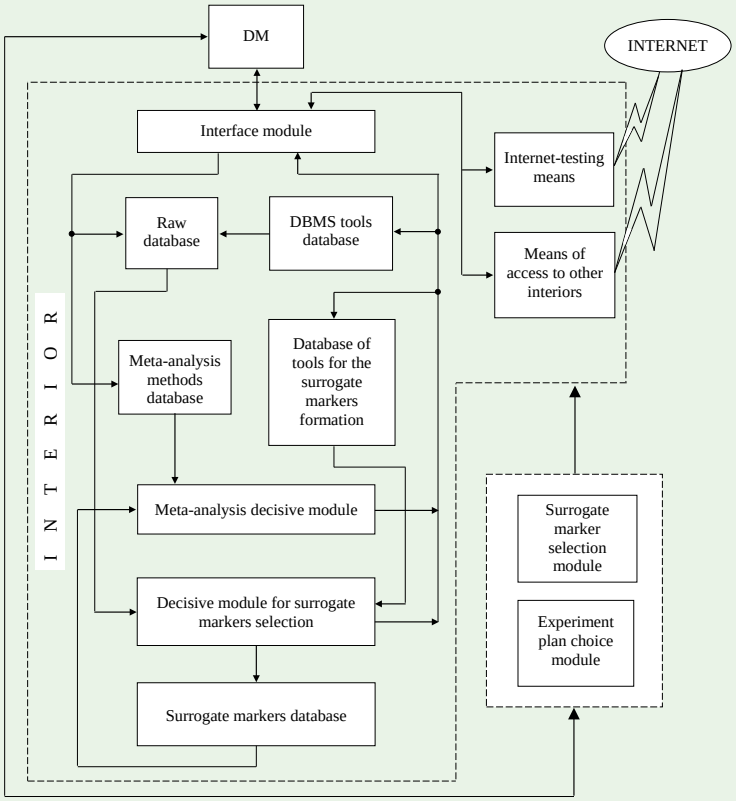

Figure 1: The structure of the interior.

At the beginning of the research, a selection of surrogate markers is made and a plan for the experiment is drawn up. The control of the effectiveness of therapeutic procedures through the interior is realized in three stages.

At the first stage, surrogate markers are selected, based on the monitoring of which a decision is made about the effectiveness of the therapeutic procedure.

At the second stage, a distributed database is created that allows the generation of data and the formation of surrogate markers intended for monitoring the effectiveness of therapeutic procedures.

At the third stage, a meta-analysis of the information on surrogate markers collected in a distributed database is made, which results in the decision on the effectiveness of the therapeutic procedure.

For software implementation of the interior, according to the structure shown in Figure 2, different software products are needed, used as a tool. It should be noted that the interior should have constant access during the execution of program procedures, so the tools should be on the web service (Figure 3). In addition, the web service may contain part of the interior database.

Thus, the DM creates a community of remote users who can

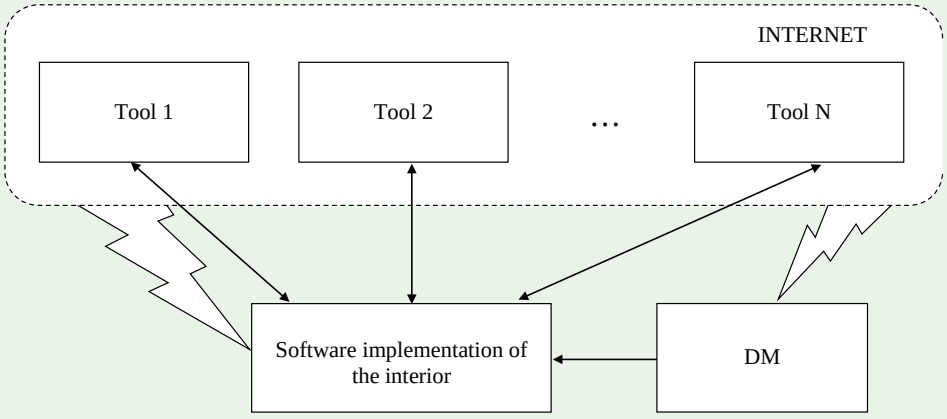

Figure 2: The structure of the Web service and its main modules.

Citation: Tomakova RA, Brezneva AN, Khanykov AE and Alexeev VA. System Decision Support Based on Internet Technologies to Predict Control Living Systems. SM J Biomed Eng. 2018; 4(1): 1026.

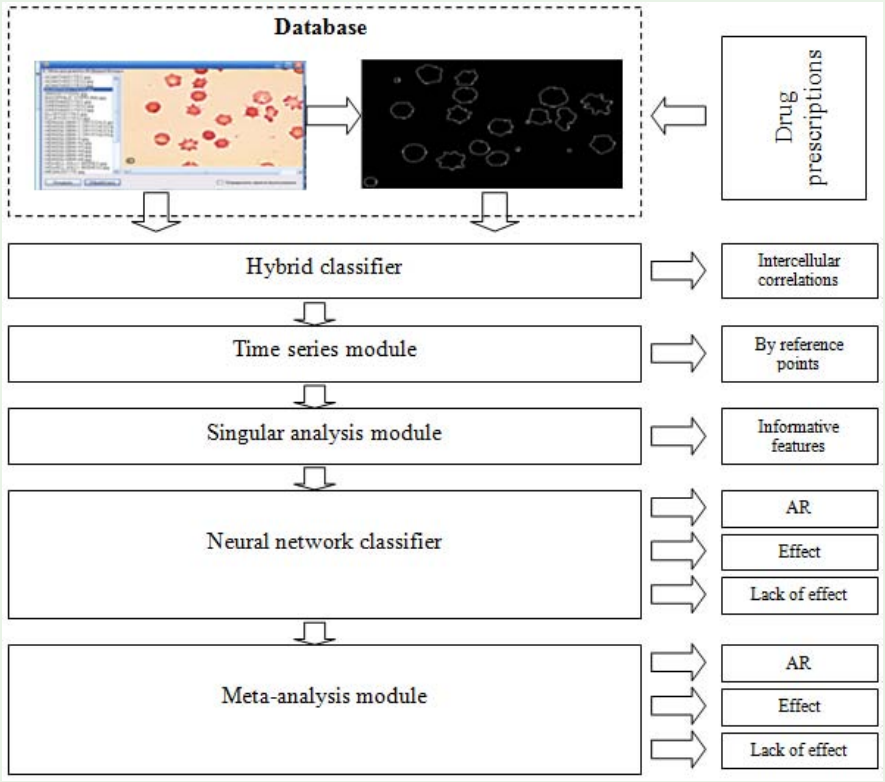

Figure 3: Web service structure and its main program modules. The drug prescriptions effectiveness monitoring based on the intercellular correlations control in the peripheral blood smears.

provide him with information about surrogate markers measured in the course of control actions based on the application of the web service software. The information, which has been researched in the process of research, makes it possible to evaluate the dynamics of the functional state of a living system (for example, a person) in the process of controlling influence on it. Thus, the chain is realized: pathology - therapeutic procedure - surrogate marker - meta-analysis. Developed software for the interior designed to work with the web service, which are the manager of both the distributed database and the community of interiors.

An Example of Implementing a Web Service

As an example, consider a Web service that allows you to monitor the effectiveness of medicinal prescriptions based on surrogate markers obtained by monitoring intercellular relationships in peripheral blood smears [3,8-11].

The structure of the Web service that provides meta-analysis of microscopic images of peripheral blood smears and storage of information about the form of medicinal effects and blood elements involved in the development of pathological conditions is shown in Figure 2.

Software modules for implementing the proposed algorithmic solutions are presented in the structure of the Web service in Figure 3.

Web service software implements algorithms for determining intercellular relationships in peripheral blood; monitors the dynamics of intercellular relationships on microimages of peripheral blood smears; identifies erythrocytes, leukocytes, platelets and rosette structures [10,12,13].

The task of the module "Hybrid classifier" (Figure 3) consists in the analysis of intercellular relationships in the smears of peripheral blood on the aperture of therapeutic procedures. The next module constructs a time series, which allows one to evaluate the evolution of intercellular relationships during the therapeutic intervention, taking into account a possible lag, for example, through singular analysis modules and a neural network classifier. Analysis of the results of classification of time series of blood characteristics in different experiments from different data sources makes it possible to evaluate the meta-analysis module.

To analyze the dynamics of intercellular relationships in the web service software, it is necessary to add target selection procedures, that is, those organs to which the therapeutic effect is directed, and reference points that establish intercellular correlation analysis intervals, distributed database management tools, and meta-analysis of the effectiveness of drug prescriptions.

To ensure the operation of the module you need a user interface, a software package for digital image processing, a database. The structural scheme of the functional interaction of the module with these software products is presented in [8-10,14].

Formed elements of blood were classified according to two independent groups of symptoms. The first group includes color indicators; to the second - the geometric parameters of the elements (size and shape). Therefore, the classification algorithm is based on a

Table 1: Initial data for clusterization by indicators of laboratory analysis of capillary blood.

Index	BPH	PCa	Date				
			07.02	15.03	05.05	28.06	14.08
Eosinophils,%	2,4	0,6	1	4,4	2	3	5
Lymphocytes,%	36	24,9	29	27,6	30	30	33
Monocytes,%	7,1	5,1	9	11,7	9	6	10
ESR, mm / hour	5,5	20,4	10	9	10	6	8

hybrid principle that takes into account both the geometric and color characteristics of the blood elements [3,8,9,11,14-16].

As an example, we will give an overview of the effectiveness of medicinal prescriptions in patients with prostatitis. The mean values of the leukocyte blood counts in healthy individuals, patients with benign prostatic hyperplasia and prostate cancer are given in [17]. In this case, the set of values of indicators for each group of surveyed persons can be taken as the corresponding class of objects. In a multidimensional space, each of these classes has its own point.

According to the indices of the leukocyte formula of blood and ESR of the diagnosed patient, it can be attributed to the corresponding class. In this case, the criteria for assigning to one or another group will be the distance in the multidimensional space between the diagnosed point and the point corresponding to one of the classes - the "center of the class", and the criterion for the effectiveness of medicinal prescriptions will be the dynamics of this distance change to the class of "HEALTHY".

During the treatment, the totality of the parameters of the leukocyte blood formula and the ESR of the diagnosed patient will change. The movement of the point of the diagnosed patient towards the point corresponding to the image of healthy patients indicates the effectiveness of the treatment. It should be noted that different rates of movement of the point of the diagnosed patient to the image of healthy persons will correspond to different methods of treatment.

If C2 is the distance between the points corresponding to the image of prostate cancer and the point of the diagnosed patient, and C1 is the distance between the points corresponding to the image of benign prostatic hyperplasia and the point of the diagnosed patient, then the higher the value D = C2 / C1, the closer the patient is diagnosed to the appearance of benign prostatic hyperplasia.

Initial data: the basis for conducting a cluster analysis, laboratory studies of capillary blood are given in Table 1.

Cluster analysis was performed on the basis of the technique [12,13,18], the results of calculations of the distances in the feature space are given in Table 2.

An increase in the value of the coefficient D indicates the effectiveness of the treatment.

Table 2: Intercluster distance calculation D.

№ p/p	Date	*D*
1	07.02	1,47
2	15.03	1,14
3	05.05	1,7
4	28.06	2,51
5	14.08	2,67

Conclusions

Scientific and technical results can be used in the clinical diagnosis of various diseases, the formation of atlases of reference images of blood cells in the process of medicinal action on them. By providing appropriate services to a remote user, the web service builds up its own database of images of peripheral blood smears, which is used both for obtaining (learning) the decision modules of its own software, and for providing training services for classifying or diagnostic models of the remote user. Using the possibilities of working with remote users, the web service will provide for its database information about the effect of the medicinal effect on the value of intercellular relationships and the blood constituents involved in the development of pathological conditions.

The obtained results are potentially in demand by both medical institutions and educational institutions; organizations Scientific and technical results can be used in the clinical diagnosis of various diseases, the formation of atlases of reference images of blood cells in the process of medicinal action on them. By providing appropriate services to a remote user, the web service builds up its own database of images of peripheral blood smears, which is used both for obtaining (learning) the decision modules of its own software, and for providing training services for classifying or diagnostic models of the remote user. Using the possibilities of working with remote users, the web service will provide for its database information about the effect of the medicinal effect on the value of intercellular relationships and the blood constituents involved in the development of pathological conditions.

The obtained results are potentially in demand by both medical institutions and educational institutions; organizations.

References

1. Tomakova RA, Philist SA, Zhilin VV, Gorbatenko SA. Structural and functional solutions of fuzzy neural networks for intelligent systems of analysis of different types of features. Fundamental and Applied Problems of Engineering and Technology. 2011; 1: 85-91.
2. Kravets AD, Petrova IYu, Kravets AG. Aggregation of information on advanced technologies on the basis of automatic generation of intelligent agents of multi-agent systems. Prikaspiysky Journal: Management and High Technologies. 2015; 4: 141-148.
3. Kurochkin AG, Zhilin VV, Filist SA, Surzhikova SA. Use of hybrid neural network models for multi-agent classification systems in a heterogeneous space of informative features. Pre-Caspian Journal: Management and High Technologies. 2015; 3: 85-95.
4. Kurochkin AG, Protasova VV, Filist SA, Shutkin AN. Neural network models for meta-analysis of medico-ecological data. Neurocomputers. Development, application. 2015; 6: 42-48.
5. Philist SA, Uvarova VV, Shutkin AN. Structural and functional model of meta-analysis of medical-ecological data. Questions of radio electronics. Series "General technical" (OT). 2015; 7: 102-110.
6. Shutkin AN, Kurochkin AG, Protasova VV. Neural network models for meta-analysis of medical and environmental data. Neurocomputers: development, application. 2015; 6: 48-54.
7. Shutkin AN, Kudryavtsev PS, Protasova VV. Structurally functional model for monitoring the influence of control actions on the functional state of self-organizing systems. Caspian Journal: Management and High Technologies. Scientific and technical journal. 2015; 2: 105-119.

8. Tomakova RA, Filist SA. Method of processing and analysis of complex structure images based on the built-in functions of the MATLAB environment. Bulletin of Transbaikal State University. 2012; 1: 3-9.

9. Tomakova RA, Philist SA, Neser AA. Fuzzy neural network technologies for isolating segments with pathological formations and morphological structures on medical images. Biomedical radioelectronics. 2012; 4: 43-49.

10. Tomakova RA, Philist SA, Zhilin VV, Borisovsky SA. The software of the intellectual classification system of blood elements. Fundamental research. Part 2. 2013; 10: 303-307.

11. Philist SA, Shatalova OV, Efremov MA. Hybrid neural network with macro layers for medical applications. Neurocomputers. Development, application. 2014; 6: 35-39.

12. Tomakova RA, Brezhneva AN, Korsunsky NA. Construction of a pattern recognition system based on the implementation of the method of potential functions. Monitoring. Science and technology. 2017; 2: 46-50.

13. Tomakova RA, Emelyanov SG, Philistine SA. Intellectual technologies of segmentation and classification of biomedical images: monograph. Kursk, Russia: South-West state university. 2012.

14. Tomakova RA, Filist SA, Pykhtin AI. Comparative Analysis of Segmentation Efficiency Method The Halftont Image Based on the Selection of Priority Direction of Machining Segment Boundaries. International Journal of Applied Engineering Research (IJAER). 2016; 5: 3199-3206.

15. Dyudin MV, Zuev IV, Filist SA, Chudinov SM. Automatic classifiers of complex structured images on the basis of multimethod technologies of multicriteria choice. Questions of radio electronics. Series “Systems and means of information display and control of special equipment” (SOIU). 2015; 1: 130-140.

16. Tomakova RA, Philist SA, Tomakov MV. Hybrid technologies in intelligent drug identification systems. Neurocomputers. Development, application. 2014; 6: 31-34.

17. Arseniev AA, Makarov VK. Investigation of the state of immunoreactivity in patients with chronic prostatitis and prostate cancer. Bulletin of VolgMU. 2010; 2: 34-36.

18. Benadict Raja J, Ravichandran CG. Automatic localization of fovea in retinal images based on the mathematical morphology and anatomic structures. International Journal of Engineering and Technology (IJET). 2014; 6: 2171-2183.