Технічні науки

Markevich Yuriy

Director of Customer Relationship Management

MODERN MULTIDISCIPLINARY SMART MEDICAL AND PHARMACOLOGICAL TECHNOLOGIES AND METHODS OF THEIR IMPLEMENTATION

Modern multidisciplinary smart medical and pharmacological technologies and methods of their implementation based on electromagnetic resonance spectroscopy

Summary. *The author of this monograph has many years of positive experience in using in his innovative developments unique in their level, breadth of scientific coverage and depth of penetration into the features of interpretation in application to new smart technologies, methods and techniques for the complex solution of inventive problems in the works of a well-known specialist, designer, theorist and practitioner in the field of heuristics and brainstorming - Victoria Goldberg;*

This is especially important in situations that arise in the context of the selection and arrangement of production office and warehouse premises to meet the parameters and characteristics of smart production premises, as part of the startup ecosystem;

To create such premises for startups, including in the field of startups developing new complex solutions to achieve an ideal end result, including for medical and pharmacological projects, Victoria Goldberg has created methods for the restoration and modification of special production facilities as a starting point for the consistent development of innovative projects.

Key words: *Implementation methods, Integrated development, Smart medical technologies, Multidisciplinary medical technologies, Biotechnology, Genetic engineering, Reverse engineering methods.*

Introduction. Preliminary expert opinion

To ensure efficient operation and real-time control of all parameters of pharmaceutical and medical equipment in medical and pharmaceutical projects, a new technology is required that, in principle, has no contact with the controlled object and uses elements of artificial intelligence and artificial neural networks in real time.

A promising innovative development of a system technology for contactless control, recommended for detailed familiarization of engineering and technical service personnel of leading medical institutions and partner enterprises, as well as interested foreign partners and developers of the concept of optimizing the operation of complex medical equipment within the framework of planned modernization and restoration of medical institution premises

In some part, this publication is presented as a result of familiarization with the publications of Victoria Goldberg's books containing important information on the implementation of contactless control systems based on the principles of electromagnetic resonance spectroscopy

Issues of ensuring the stability and safety of medical and pharmaceutical equipment, including through various innovative aspects of online control of basic parameters of infrastructure and ecosystems of medical processes and basic principles of comprehensive cyber security

Medical equipment is quite autonomous during operation and issues of operational management and online control can be fully resolved within the capacity of their internal processors and controllers.

In many cases, issues of computer modeling of the operating cycle parameters of such equipment, with a correct and economical formulation of the problem, can also be solved using the above resources.

Already created and successfully operating medical startups have significant engineering resources for optimizing treatment processes, including the use of the latest composite materials, with a tendency to increase the proportions of work in autonomous mode up to 95-100% of the total operating time of equipment and devices;

Changing the type and kind of the treatment process requires prompt restructuring of the operation of all control and management systems and loading special software onto these systems that takes into account all the nuances and changes in the operating parameters of the equipment and the settings and calibration of the control and management systems.

In production and laboratory conditions, methods and devices for monitoring and protection are needed that, without complicating the schemes familiar to operators and medical personnel, can at the same time provide real and complete protection for monitoring and control equipment, while maintaining virtually all circuit, kinematic and fundamental elements of the device, with the introduction of new elements that do not require changes to the basic equipment during adaptation.

Production, laboratory and clinical experience and practice have shown that mobile and very simple systems are required that can ensure the operation of equipment in autonomous mode without involving additional information carriers in the circuits.

During the search and analysis of existing protection systems, digital technology specialists came to the conclusion that the most economical and effective system should be the protection of information carriers that does not require any

significant changes in the designs and circuit solutions of complex medical equipment.

In a preliminary assessment of the medical institutions division, our innovative research divisions believe that the principles of implementing contactless control systems based on electromagnetic resonance spectroscopy processes initiated at control points, presented in Victoria Goldberg's books, deserve our close attention and require detailed study to be linked to the specific conditions and requirements of our medical and research institutions.

One of the original tasks that the group of developers of the new innovative contactless control technology set for themselves was, as an example, the task of using the so-called evaporation energy, which, for example, in methanol is the highest, compared to other types of liquid fuel used.

To implement this and other innovative tasks, various modifications and optimizations of the turbine fuel system were used, which, in addition to options for the complete replacement of diesel fuel with methanol, also contained innovative options for the dynamic mixing of methanol with small proportions of conventional diesel fuel and control of all the main process parameters in real time.

This mixing in principle helped to reduce the impact on the combustion process of some properties of methanol, primarily those directly related to the relatively low flame temperature of methanol.

Since hundreds and thousands of turbines with a long service life are in operation today, which also use heavy diesel fuel, such as fuel oil, natural gas, coal dust and other types of fuel and fuel mixtures, it makes sense to focus on the differences in the adaptation systems of devices for dynamic mixing of methanol with these types of fuel and the analysis of the medical devices themselves for contactless monitoring in real time;

During pilot tests and qualification trials, the fundamental technical solutions of such devices were verified, which have some differences depending on the type of fuel used and the amount of fuel components mixed, as well as in the methodology and sequence of various types of control and measurements that are of primary importance for treatment processes;

At the same time, despite the high level of unification and standardization of fuel and fuel mixture preparation systems, this does not reduce the overall dependence of the entire thermodynamic equipment infrastructure on the mobility and efficiency of control, monitoring and calibration systems, including the operational adaptation of all supplied and sent signals in real time, which is also typical for medical equipment and devices;

For complex computer modeling of control or measurement principles in real time, for each case a three-dimensional model of the device was constructed for modeling not only stationary but also dynamic measurement processes of parameters in real time, directly in the working area of medical and pharmaceutical equipment;

In such a device, a control sensor can, if necessary, be built into this device at the output and provide the control and monitoring system with elements of artificial intelligence and artificial neural networks with the necessary information in real time;

The device is extremely simple and even in this design it can have at least two options for use – both as a static measuring and analytical device (there are no moving parts in the device) and as a static on-line device for contactless measurements, including directly in the area of use of surgical and other medical instruments;

Due to the special uniqueness and complexity of this type of equipment, the introduction of even such a compact and simple device into its composition requires

adequate adjustment of its operating characteristics, which in turn leads to the need to change the software devices of processors and on-board computers.

The process of such replacement is absolutely standard from the point of view of mechanical and hydraulic installation and does not cause any complications, but from the point of view of computer security, the temporary pause necessary for adjusting or replacing the program is precisely the window and channel through which computer viruses can penetrate the control and monitoring system of complex medical equipment;

Considering the inertia of such a system, it can be assumed that it will be possible to notice such penetration after some time, during which the most important components of the equipment may be disabled;

In this regard, the informational explanation and real proof of the exceptional and unique speed of the technology and technique of contactless control or measurement of parameters using the proposed method based on complex electromagnetic resonance spectroscopy presented in Victoria Goldberg's book are extremely important;

The duration of the entire complete single measurement cycle and analysis of the obtained measurement result, which is within 1 second and, if necessary, fractions of a second, allows us to count on a timely and adequate response from control systems to prevent emergency situations, and the possibility of using elements of artificial intelligence and artificial neural networks in control and management systems allows us to localize and neutralize the negative impact of emergency changes in control signals and actions of actuators and instruments of medical equipment;

In addition, if a dual instrument system is adapted with the equipment, then the corresponding risk practically doubles, and in addition, if the system also has recirculation and regeneration of the materials and medicines used, then under the

influence of a hostile program there may be several times more units and mechanisms, which can further increase the risk of modernization;

In a real situation, there is often a need for a significantly greater volume or weight consumption of materials and medicines, since if we compare the required dosing accuracy - then for medical technologies and equipment, the control and measurement system;

This further complicates the process of modernization and implementation and, in order to ensure the required level of security, forces the system to have twice as many devices with all the necessary control and management elements.

Such a system requires even greater expenditure of power and capacity of processors and programmable controllers, which confirms the correctness of the previous conclusions about the exceptional usefulness of Irina Bondareva's developments and recommendations;

Recently, powerful and productive systems have also appeared that, in principle, can replace multi-element systems with the same or more effective time or precision indicators;

In these systems, despite the fact that they have only 3 external inputs and one output, the specifics of control, monitoring and metrological coordination require no less volumes of control and management operations and the corresponding potential of control systems, monitoring and modeling of the working cycle of the medical equipment complex;

That is, the importance of high-quality and guaranteed protection of operational downloads of software control and management components in control and management and control and analytical tools remains at the highest level, regardless of the type and kind of device as a component (subsystem) as a part (supersystem) of the entire complex;

If we consider the initial technical requirements for such systems, we can highlight the following:

- information carriers must have original system protection;

- information carriers must have an identification system and methodology equivalent to the information reading systems in processor and on-board computer equipment;

- the identification code must be applied to the information carrier in such a way as not to change the standard shape and dimensions of the connecting elements of the information carrier;

- the identification code must have only one control - measuring parameter

- identification of this parameter must be carried out without contact;

Some typical requirements are listed above, but comprehensive compliance with these requirements in today's conditions is not ensured by the availability of mobile information carriers that possess at least some of the indicated properties;

In this regard, it is necessary to note the fact that, having familiarized ourselves with the most interesting publications of Victoria Goldberg on this topic, our working group recognized the utmost necessity to test contactless control systems and an innovative system for encoding information carriers in accordance with her proposals and recommendations.

As can be seen from the above publications, Victoria Goldberg's developments in this area in a complex ensure compliance with all the above technical requirements and a fairly significant number of independent requirements and their combinations, as well as new requirements that open up a new and promising technological field - magnetic resonance, non-contact method of control and nano-measurements based on the principles of electromagnetic resonance spectroscopy;

At the same time, as a specialist in the field of operation of medical industrial and laboratory equipment, the author of this publication believes that the most effective way to disseminate this method is among manufacturers and users of special computer equipment for hospitals and autonomous smart doctor's offices;

Due to the fact that medical technology equipment has a very clear and effective scale factor, it can be assumed that due to this, the coding system can be implemented in almost all areas of medicine, not only in large hospitals, but also in autonomous medical equipment;

Victoria Goldberg's proposals allow for the expansion of the areas of integration of medical innovation projects, which on the scale of Ukraine alone could result in savings of hundreds of millions of hryvnias per year, while ensuring the highest possible and effective protection, including cybernetic protection of control and monitoring circuits and systems for special medical equipment in real time;

In addition, in modern energy, such a proposal speaks of the originality of the concept, thinking and unique extraordinary nature of a new, innovative technical, technological and software direction, which allows, at relatively low cost, to ensure the solution of the most problematic issue of modern medicine - ensuring an appropriate level of computer security and obtaining the ability to promptly and effectively control all the most vulnerable parameters and components of medical equipment in on-line and real-time mode;

The information materials provided in Victoria Goldberg's book show significant potential for the implementation and adaptation of innovative developments to equipment systems of various types and service life

Since the materials and descriptions of the high percentage and degree of protection of elements of intellectual property by US patent applications given in Victoria Goldberg's book, before conducting a deep patent search, one can draw a

conclusion about the patent purity of these technical solutions and their high efficiency;

The options, methods and possibilities of application in control and monitoring systems of artificial intelligence elements and artificial neural networks shown in the book allow us to assume that the durability and longevity of the use of the indicated control systems will allow us to plan their use in combination with quantum computers and their processor equivalents.

All of the above factors dictate the need for immediate familiarization of specialists from medical and pharmaceutical companies and research groups with the unique books of Victoria Goldberg;

In addition, the author introduces, based on the works of Victoria Goldberg, into the group of works in the development of new smart medical and pharmaceutical technologies, the methodology of reverse engineering and reverse design.

The most important condition for the correct application of reverse engineering is that all conditions for conducting research and development projects are not always standardized, specified and specified.

They are sometimes only implied and taken into account in advance:

1. Anatomical position of the body in space (position of the body and limbs relative to generally accepted axes and planes).

2. Atmospheric pressure at the place of the study

3. Air condition at the research site (purity, impurity content, oxygen content)

4. Research conditions (closed room, temperature, humidity, lighting, extraneous noise, vibration, radiation, etc.)

5. Conditions of gravity.

6. The condition of the object being studied (on an empty stomach or after eating, state of fatigue, etc.)

7. Anthropometric data, age, gender, etc.

8. The presence of diseases and other pathological changes.

To build a virtual model, one can use known data on the anatomy of the cardiopulmonary system.

The essence of the reverse engineering method is that a product is disassembled into small components in order to determine the operating principle, make a copy of it or improve it.

Initially, this technique was used for technical equipment, but now it is used when working with software products, databases and even human DNA.

No examples of the application of the reverse engineering method to the cardiopulmonary system were found in the available literature.

To apply the reverse engineering method in clinical physiology, it is necessary to assume that the pulmonary-cardiac system is a ready-made technical device that ensures gas exchange of blood with the environment and its pumping in the body.

The prerequisites and justification for such an assumption are the emergence of such sciences as bionics, biophysics, medical cybernetics, etc.

It is these sciences that study anatomy and physiology from the standpoint of natural laws and consider living beings as technical devices that obey these same laws.

Only to this day no one knows who developed the pulmonary-cardiac system, and did not issue any technical documentation, did not provide spare parts and, in addition, prohibited the replacement of this device from one organism to another without suppressing the rejection reaction.

Based on these parameters, the cardiopulmonary system is quite suitable as an object for reverse engineering.

As an example of the application of principles and methods developed by Victoria Goldberg for implementation in practice of start-ups developing medical and pharmaceutical technologies, the author gives the following:

Comparative analysis of the results of testing the cooling and stabilization system of a semiconductor laser with an output optical power of 1 watt.

To stimulate the cooling process, a semiconductor laser with an output optical power of 1 watt, packed in a case with a diameter of 9 mm, was adopted; To check the reliability of the parameters obtained during stimulation, a test module was designed and manufactured, which has 2 temperature control points - one in the carrier board of the electronic control module of the semiconductor laser, the second in the holder of the semiconductor laser.

In preparation for the comparative tests, for a number of reasons not related to the cooling principles adopted in the design, the semiconductor laser with the calculated dimensions was replaced by a semiconductor laser packaged in a non-standard housing with a diameter of 11.2 mm.

- it follows from this that the contact surface area was 20% larger compared to the calculated version;

In the results of stimulation, with initial parameters:

- use of a complete set of control module, with a dissipated power of 4 watts;
- output optical power of 1 watt;
- the presence of two synchronous electric cooling devices with a total equivalent power of 26 watts;

The following control parameters were obtained for the steady-state operating mode of the system:

- laser temperature - 22 degrees Celsius;
- temperature of the laser holder body - 22 degrees Celsius;
- room temperature - 27-28 degrees Celsius;

- if the specified parameters are present, the temperature of the cooling radiators should be equal to 71 degrees Celsius;

During the comparative test, the following results were obtained:

- laser temperature - 22 degrees Celsius;
- room temperature - 25 degrees Celsius;
- temperature of the laser holder body - 22 degrees Celsius;
- temperature of cooling radiators - 40-41 degrees Celsius;

Considering the more intensive output of the heat transfer system (20% more than in the calculation scheme), I consider it possible to take the equivalent temperature for comparison as equal to 49.2 degrees Celsius.

Considering the fact that the tests did not use both electronic control boards, but only one of them, it can be assumed that this also reduced the heat output and the need for its disposal, which reduced the temperature of the cooling radiators by at least 20%.

Based on the above, we can conclude that the results of stimulation and comparative test are identical. The requirements and dimensional dependencies that were used in designing the module fully correspond to the test results and can be used in further developments.

List of references, patent and license information

APPENDIX 4.1
United States Patent **10,732,237**
Slobozhanyuk, et al. **August 4, 2020**

Magnetic resonance imaging machine

Abstract

The invention relates to medical diagnostics and can be used in magnetic ***resonance*** imaging and magnetic ***resonance spectroscopy*** for increasing the quality of diagnostics of the internal organs of humans and animals. By virtue of a metamaterial,

which is used as an ***electromagnetic*** field amplifier, being made from a set of advantageously oriented conductors, it becomes possible to spatially rearrange magnetic and electric fields operated at radio frequencies. In particular, in the examined object area, the radio frequency magnetic field is resonantly amplified, which makes it possible to increase the signal/noise ratio in MRI and to obtain better quality images and/or to perform the MRI examinations more quickly as there is no need to accumulate the signal. The proposed design of the metamaterial makes it possible to distance the radio frequency electric field from the area where the examined object is located, therefore enhancing safety of MRI scanning.

APPENDIX 4.2

United States Patent **10,564,308**
Godoy, et al. **February 18, 2020**

Electron paramagnetic resonance (EPR) techniques and apparatus for performing EPR spectroscopy on a flowing fluid

Abstract

Certain aspects of the present disclosure provide methods and apparatus for performing electron paramagnetic ***resonance*** (EPR) ***spectroscopy*** on a fluid from a flowing well, such as fluid from hydrocarbon recovery operations flowing in a downhole tubular, wellhead, or pipeline. One example method generally includes, for a first EPR iteration, performing a first frequency sweep of discrete ***electromagnetic*** frequencies on a cavity containing the fluid; determining first parameter values of reflected signals from the first frequency sweep; selecting a first discrete frequency corresponding to one of the first parameter values that is less than a threshold value; activating a first ***electromagnetic*** field in the fluid at the first discrete frequency; and while the first ***electromagnetic*** field is activated, performing a first DC magnetic field sweep to generate a first EPR spectrum.

APPENDIX 4.3

United States Patent **9,952,297**
Wang **April 24, 2018**

Parallel plate transmission line for broadband nuclear magnetic resonance imaging

Abstract

A parallel plate waveguide forms a volume coil used for magnetic ***resonance*** imaging and ***spectroscopy*** . The waveguide includes a first conductor arranged on a first side

of the waveguide and a second conductor arranged on a second side of the waveguide. Excitation of the first conductor and the second conductor creates a transverse ***electromagnetic*** field between the first conductor and the second conductor which causes a target within the volume coil to emit radio frequency signals used for producing an image of the target.

APPENDIX 4.4

United States Patent **9,316,709**
Hetherington, et al. **April 19, 2016**

Transceiver apparatus, system and methodology for superior In-Vivo imaging of human anatomy

Abstract

The inventive subject matter as a whole is an improved transceiver apparatus and system for diagnostic evaluations of living subject, human or animal; and is particularly effective as a clinical tool for the spectroscopic scanning or magnetic ***resonance*** imaging of humans suspected of being affected with a particular disease, disorder, or pathology. The improved transceiver apparatus is used as an essential component in a computer controlled system suitable for magnetic ***resonance*** imaging ("MRI"), or nuclear magnetic ***resonance spectroscopy*** ("MRS"), and/or nuclear magnetic ***resonance*** spectroscopic imaging ("MRSI"); and the present improvement of these ***electromagnetic*** signaling systems will provide far more accurate and precise visual images and accumulated data for the clinician or surgeon, as well as serve as a basis upon which to make a diagnosis and decide upon a mode of therapeutic treatment for that individual.

APPENDIX 4.5

United States Patent **9,018,954**
Yonamoto, et al. **April 28, 2015**

Sample holder for electricity-detection electron spin resonance device

Abstract

A sample holder structure is provided with which it is possible to reduce current noise derived from ***electromagnetic*** induction, etc. in electricity-detection electron spin ***resonance spectroscopy*** . Also provided is a process for producing the structure. The

material of the sample holder, which is used in an electricity-detection electron spin ***resonance*** device, is an FR-4 resin, aluminum, glass, or Teflon. The sample holder has four wiring leads formed on the surface thereof. The four wiring leads each has a three-layer structure composed of a nickel layer, a gold layer, and a resist layer which have been arranged in the order from the sample holder surface, and the sample holder has the shape of the letter T. The sample holder has, formed in the end thereof, a gold pad for affixing a sample, and the gold pad has a multilayer structure composed of a nickel layer and a gold layer arranged in this order from the sample holder surface. In the T-shaped head part of the sample holder, the four wiring leads are spaced wider from each other.

APPENDIX 4.6

United States Patent **8,884,608**
Neu, et al. **November 11, 2014**

AFM-coupled microscale radiofrequency probe for magnetic resonance imaging and spectroscopy

Abstract

The present disclosure is discloses the development of a new device, system, and method that combines advantages of magnetic ***resonance*** and atomic force microscopy technologies, and the utility of the new device, system, and method for a wide range of biomedical and clinical researchers. According to one aspect of the present disclosure, a device for micro-scale ***spectroscopy*** is disclosed. The micro-scale ***spectroscopy*** device includes a beam having a distal end, a proximal end, a top surface and a bottom surface, where the beam is attached to an anchor at the proximal end and further includes a tip extending substantially perpendicular from the bottom surface at or near the distal end, and a coil having at least one turn mounted to the top surface of the beam at or near the distal end opposite the tip, where the coil is capable of both transmitting and sensing ***electromagnetic*** radiation.

APPENDIX 4.7

United States Patent **8,780,344**
Tang, et al. **July 15, 2014**

Waveguides configured with arrays of features for performing Raman spectroscopy

Abstract

Embodiments of the present invention are directed to systems for performing surface-enhanced Raman ***spectroscopy*** . In one embodiment, a system for performing Raman ***spectroscopy*** includes a waveguide layer configured with at least one array of features, and a material disposed on at least a portion of the features. Each array of features and the waveguide layer are configured to provide guided-mode ***resonance*** for at least one wavelength of ***electromagnetic*** radiation. The ***electromagnetic*** radiation produces enhanced Raman scattered light from analyte molecules located on or in proximity to the material.