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Recent advances in Electrophotonic Image Processing

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Abstract: Discussion of the physical principles and recent advances in the Electrophotonic Imaging (Gas Discharge Visualization) technique is presented. Special attention is given to the description of the latest patents. It is shown that the Electrophotonic imaging method has a long history and with introduction of digital image processing became useful practical tool for alternative/complementary medicine and integrative healthcare. Bio-Well instrument (www.bio-well.com) follows the latest trends in modern development: all image processing is done on server, which protects from viruses and hacker attacks and allows regularly offer customers free updates. This opens up perspectives for using Bio-Well instrument for the scientific research.

Keywords: Electrophotonic imaging, Gas Discharge Visualization, healthcare, wellbeing.

1. INTRODUCTION

As shown in [1,2]. "image formation in gas discharge around objects of a different nature initiated by strong impulsive electromagnetic fields has been known for more than two centuries, from 1777, when German physicist Georg Lichtenberg found out the lightning of different subjects in electrical fields. In XIX-XX centuries hundreds of researchers practiced with photographing these discharge images. The most known became the works of Soviet researchers Semion and Valentina Kirlian, after them this effect was given the name Kirlian effect". Different researchers demonstrated that gas discharge images around biological objects can provide substantial information about the internal state of the object. In particular, the gas discharge images of human fingers are actively used by physicians for diagnostic purposes [1,3,4,5]. A number of research works was devoted to the physical nature of image formation [1,7,8]. It turns out that one of the most difficult problems is finding an adequate quantitative description of the process due to the high nonlinearity of gas discharge. Moreover, this nonlinearity comes on top of extreme complexity of the biological objects themselves. In this paper we briefly outline the recent development both in image processing and in constructing practical devices.

2. BASIC PRINCIPLES OF ELECTROPHOTONIC IMAGING TECHNIQUE: EXPERIMENTAL SCHEME

The scheme of the experiment is shown in Fig. 1. Transparent conductive layer 3 is evaporated onto the bottom surface of the glass plate 2. A train of duration 0.1 s of triangular 10 mks electrical impulses of amplitude 3 kV, steep rate 10^6 V/s and repetition frequency 10^3 Hz is applied to this grid. This generates electromagnetic field around the subject 1 positioned on the glass surface. Under the influence of the field the subject produces a burst of electron-ion emission and optical radiation light quanta in the visual and ultraviolet range. These particles and photons initiate electron-ion avalanches, giving rise to a sliding gas discharge 5 along dielectric surface [7,8]. The spatial distribution of discharge channels is recorded through the glass plate by the optical system 7 with charge coupled device TV camera, analog-digital processor and digitized in the computer 8. In short, this technique is called the BIO GDV technique and images after processing are called BIO grams [1].

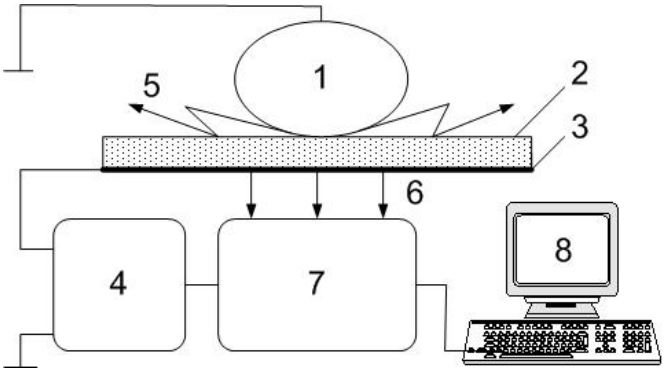

Fig.1. The scheme of the experiment. 1 - - biological object

under study; 2 – glass electrode; 3 – conductive transparent layer; 4 - generator of electric pulses; 5 – gas discharge; 6 – light radiation; 7 – optical system and CCD TV camera; 8 – computer.

In Fig. 2 a typical gas discharge image around human finger is shown. This image is a set of pixels with a certain luminosity assigned to every pixel. The central oval shape of the image represents fingerprint, typically luminosity monotonically decreases along any radial direction.

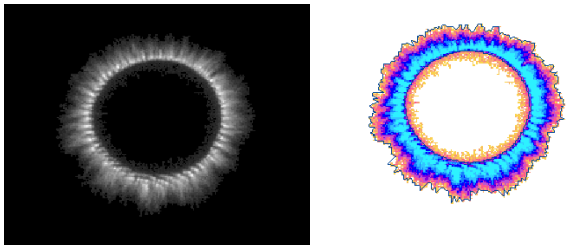

Fig.2. Typical gas discharge image around human finger before and after image processing.

Processing algorithms were developed in [7]: "To process the image numerically, we first find the position of the center of the inner oval with luminosity playing the role of image density. Then we construct curves of constant luminosity isolines, which are closed curves surrounding the image. This curve can be described numerically as a set of numbers f_n, where n=1, . . . ,N is a ''discrete angle'' (our images have resolution sufficient to divide the whole 360^0 angle into 1028 pieces, i.e., we take N=1028). Number f_n measures in pixels the distance from the center to the isoline. The common image processing application packages cannot be used for processing BIO-grams, because the tasks are specific. Diagnostic hypotheses must be taken into account, and processing should be done on the level of decision-making systems. Therefore, a software environment was developed for processing and analyzing BIO-grams, oriented towards the work in different problem domains. Adaptation for particular assessment is performed through a combination of optimal operations from the library for the given problem domain, selection of corresponding procedures, and (or) selection of optimal threshold values".

The following main algorithms are included in the library [3,6]:

"Luminescence Area. Amount of light quanta generated by the subject in computer units - pixels (the number of pixels in the image having brightness above the threshold).

Normalized Luminescence area. The ratio of image area to the area of the inner oval (representing fingerprint).

Internal noise. Amount of light in the inner oval (fingerprint).

Isoline radius. Average radius measured from the center of an image to the external contour (isoline).

Intensity. Relative brightness of image pixels measured in computer units from 0 to 255.

Inner circle radius. Radius of the circle inscribed in the inner oval (fingerprint).

Isoline length. The length of the external contour of an image.

Isoline fractality. Fractal dimension of the external contour represented as quasi-infinite line.

Isoline Entropy. The ratio of an image's external contour to its internal contour.

Form Coefficient. Calculated according to the formula: FC = Q = $k*L^2/S$, where L is the length of an image's external contour and S is the image area".

3. ELECTROPHOTONIC IMAGING: STATE-OF-THE-ART

As was shown in many research studies, captured images (Bio-grams) of all ten fingers of each human subject provide detailed information on the subject's psycho-somatic and physiological state [1-6]. "The Electrophotonic imaging systems (previous name Gas Discharge Visualization EPI/GDV) and their accompanying software are currently the most effective and reliable instruments in the field of Bioelectrography. Through investigation of the fluorescent fingertip images, which dynamically change with emotional and physical health states, one can identify areas of congestion or health in the whole system. The parameters of the image generated from photographing the surface of a finger under electrical stimulation creates a neurovascular reaction of the skin, influenced by the nervous-humoral status of all organs and systems. Due to this, images captured by EPI/GDV register an ever-changing range of states. In addition, most healthy people's EPI/GDV readings vary only 8-10% over many years of measurements, indicating a high level of precision in this technique. Specialized software converts these readings into parameters which elucidate the subject's state of wellbeing at that time" [3-7].

This technology has extraordinary implications for all health related fields, both in conventional as well in complementary or alternative therapies, including medicine, "energy medicine", athletic training, biophysics, parapsychology, and other disciplines. Review of various applications can be found in the book [3]. For XIX years we have hosted a series of annual international scientific congresses in St. Petersburg, Russia during the last two decades that has attracted scientists from 46 countries, a lot of whom were involved in Electrophotonic research. The next, XX-th congress will be held in the beginning of June 2016 (www.sis-congress.com).

The latest development is the way to process images on server, when users of the technology (www.Bio-Well.com) need to capture images with the instrument and all information is sent to the server, where sophisticated software process the images, calculates a set of parameters and sends processed data to the user in the form of different graphs and images. The advantage of this approach is safety (software is totally protected) and possibility to present free upgrades on regular basis. Software operates both on Windows and Mac OS platforms. Bio-Well device was used in many latest applications.

Recently published study [8] was dedicated to the study of potentials of Electrophotonic analysis for detecting patients with arterial hypertension of different degree of severity in the course of population screening. Reliable differences between the control group (healthy patients) and groups with various degrees and stages of arterial hypertension were found with sufficiently high accuracy. Participants were 603 patients, aged from 18 to 83, 265 males and 338 females. All participants were classified into groups according to degree and stage of arterial hypertension and possible risk of cardio-vascular complications in the nearest 10 years. Using discriminative analysis specificity and sensitivity of the obtained classification functions obtained were up from 70% to 80%. Classification of patients according to gender increased diagnostic accuracy by 5-9%.

In another study of the same group [9] similar approach was used to identify patients with colon neoplasias. 78 people following by colonoscopy were studied: the control group consisted of 22 people, an endoscopic examination identified colon tumors in 56 people. The age of the subjects ranged from 45 to 86 years. The study analyzed Bio-grams of fingers as a whole as well as separate sectors corresponding to the organs in question. The study demonstrated statistical difference between GDV parameters of patients with colon tumors compared with control group.

Bio-Well device is actively used in preparation of the Russian Olympic and Paralympic teams. Several papers were published in Russian scientific journals and at least one in the international press [10]. In this paper evaluation psycho-physiological condition of elite athletes' from Russia's Skiing and Biathlon Paralympic Team at various stages of preparation and in international competition was conducted. It was shown that Evaluation of Bio-grams' parameters offers a fast, highly precise, non-invasive method to assess an athlete's level of readiness during both training and at the time of competition.

The use of Bio-Well in conjunction with a special sensor allows monitoring both non-selective characteristics of the environment and the functional state (in particular emotional state) of groups of people [11]. The developed method was tested during theater performances and concerts, workshops and lectures, as well as in the process of group meditation. In many cases correlation of Bio-Well parameters and emotional state of the audience was recorded. Sensor can be used in education, security services, geophysics, study of geo-active zones. Currently, different researchers use more than 100 Bio-Well devices with this sensor. These results correlate with a previously published paper [12].

Electrophotonic Imaging method may serve for testing properties of different substances: water [13], oils [14], minerals [15], and textiles [16].

4. PATENT LANDSCAPE

Many patents were dedicated to different applications of Kirlian effect. We will review only some examples.

Patent [9] protects a method of analysis of vegetovascular crises, comprises fixation and comparison of the structure of gas-discharge light emission in an electric field around the whole reference object or a part thereof (fingertips) at the initial level (outside the vegetovascular crisis) and prior to the crisis. However, such method does not provide sufficient accuracy and reliability in determining the biological object's condition, because it takes into account only one parameter of the glow structure, namely the length of the gas-discharge streamer. In addition, it should be noted that the process of obtaining the information is quite labor-intensive and lengthy: one must obtain the photographic images, measure them with common measuring tools and then compare the measurement results. Patent [10] protects a method of analysis of osteochondrosis of the cervical part of spine performed by way of radiation treatment of parts of the human body followed by image registration. The fingertips are radiated by impulse electric field with intensity $10^6 – 10^7$ V/cm with the registration of Kirlian image; if there are not more than four T-form streamers for one finger and if these are for not more than three fingers of one hand, the analysis of osteochondrosis of the cervical part of spine is performed. This method is only applied to reveal the pathologies of patients with vegetovascular dysfunction.

Patent [11] protects a method of analysis of state of the human organism, consisting in the registration of structure of gas discharge streamers of fingers in the electromagnetic field, visualization and estimation of the streamer size. The registration is performed on a layer of thermoplastic material on a dielectric plate, which is then heated up to the temperature of softening of plastic. A phase-contrast visualization of streamers is performed at that, and the size and quantity of streamers are determined in the points of classical acupuncture. In accordance with this technique, visual images of gas discharge streamers of all fingers are obtained one after another. In addition, the analysis of the organism state is based on the known data on the correlation between the particular parts of glow of one or another finger with the state of various organs and systems. These data are widely known and given, particularly, in the book [17], as well as in others sources, for example in [6].

Patent [18] concerns a method whereby an optical signal representing the amount of ionizing light of at least a gas in the proximity of an object is displayed and/or recorded. Said method is characterized in that it consists in: gradually

increasing the voltage between the object and the conductor element up to a final value wherein the maximum brightness is observed; determining, as first characteristic value of the object, the value of the voltage as from which the brightness (is not less than about 10% of the maximum brightness and in determining, as second characteristic value of the object, the voltage value as from which the brightness of the signal is not less than about 90% of the maximum brightness. The installation comprises a sensor equipped with a flexible membrane defining a volume of confinement for a gas or a gas mixture wherein the ionization occurs.

Patent [19] protects a method for determination the anxiety level of a human being. According to this patent the structures of gas discharge glow around the investigated zone of one and the same part of skin are registered through the polymer film and without it, each structure is transformed into a digital code, quantitative parameters of structures of glow reflecting the two-dimensional geometrical characteristics of structures of gas discharge glow are found, and the totality of parameters of each structure is represented in the form of a point in multidimensional space of parameters; the level of anxiety of a person is determined by the distance between the points for the structures obtained through the film and without it, the smaller the distance between the points, the lower the level of anxiety. Owing to the fact that the investigated part of skin is covered by a polymer film, the influence of factors referred to the state of vegetative nervous system (blood microcirculation and perspiration) in the zone of the investigated part of skin on the level of gas discharge glow is excluded; thus, comparing the structure of gas discharge glow of the part of skin registered through the polymer film with the structure of gas discharge of the same part, registered without it, the information on the state of vegetative nervous system and the level of anxiety (psychological stress) of a person can be obtained.

Next development of the above method is presented in [20]. Realization of the method provide the object with an important new property that consists in that the condition of a biological object is determined in comparison with metal cylinder, i.e. an object, parameters of which do not depend on the influence of temporal, climatic, geophysical and other factors, thus ensuring an increased accuracy of determination of the condition of the biological object under study.

In particular, patent [21] is proposing the method for determining hair conditions, which consists in subjecting a hair strand to the influence of an electromagnetic field, which induces the glow of the hair, and subsequently measuring the intensity of the light emission radiated by hair, the hair is subjected to the influence of the electromagnetic field at its end surfaces, whereupon the intensity of the light emission radiated by the hair at its end surfaces is measured per unit area of the total area of the hair end surfaces, and then, along with the electromagnetic field's influence upon the end surfaces of hair, the side surface of the hair strand is subjected to the influence of an electric or electromagnetic field, whereupon the intensity of the light emission radiated by the hair at its end surfaces is again measured per unit area of the total area of the hair end surfaces is calculated and used for assessing the hair conditions. Fig.3 presents the device for realization of the patent.

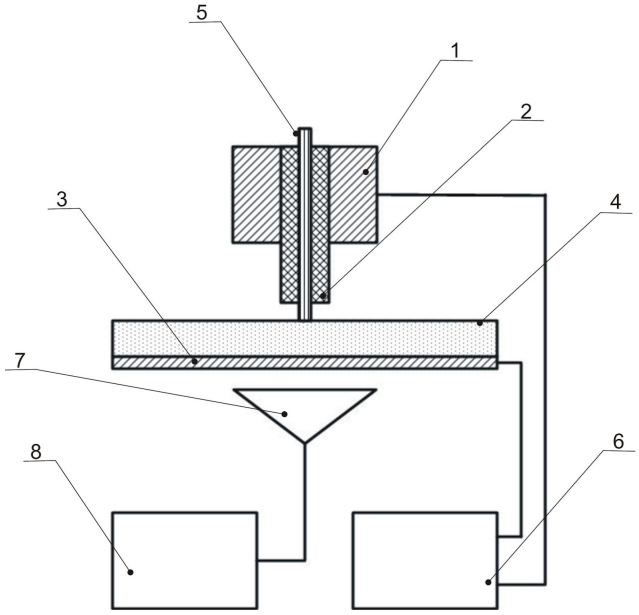

Fig.3. Device for realization method for determining hair conditions. 1 – electrode; 2 - hair holder; 3 - electrode embodied in the form of an optically transparent conductive layer; 4 - glass plate; 5 - the hair strand; 6 - electromagnetic energy generator; 7 – receiver of the light emission; 8 - device for measuring the intensity of the light emission.

This approach was found effective for the evaluation of hair quality and its change under the influence of different treatments.

Another invention [22] utilizes gas discharge properties for measuring electromagnetic field intensity. Device comprises a measuring instrument for recording the glow of a gas discharge and a gas-discharge chamber that is formed between electrodes separated by a dielectric, where one electrode is cylindrical, and the other electrode is in the form of a disk, said electrodes being coupled to an electrical voltage source, wherein a capacitive element in the form of a pair comprising an antenna and a connection to ground is incorporated into the line coupling the cylindrical electrode to the electrical voltage source, characterized in that a capacitor with variable capacitance is incorporated into the line coupling the cylindrical electrode to the antenna (fig.4). Many experiments for several years demonstrated high sensitivity of this device for detecting different situation in the environment such as sun eclipses, magnetic storms and moon cycles [6]. Interesting preliminary results were obtained in early detecting earthquakes [26]. Response of the device to the changes of human emotions was detected [27, 28].

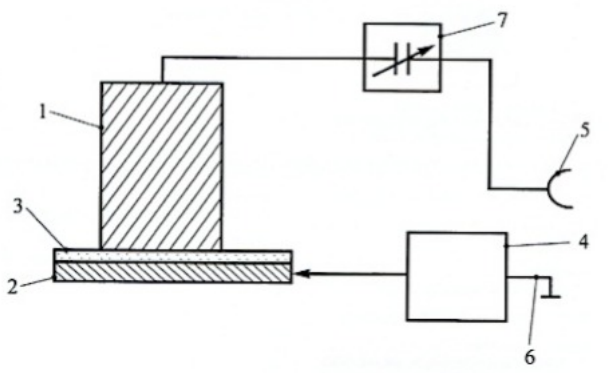

Fig.4. Device for measuring electromagnetic field intensity. 1 – metal cylinder; 2 – disc electrode; 3 – dielectric layer; 4 – electrical voltage source and measuring electronics; 5 – antenna; 6 – grounding; 7 - capacitor with variable capacitance.

5. CONCLUSION

As we can see from the presented review, Electrophotonic imaging method has a long history and with introduction of digital image processing became useful practical tool for alternative/complementary medicine and integrative healthcare. Bio-Well instrument (www.bio-well.com) follows the latest trends in modern development: all image processing is done on server, which protects from viruses and hacker attacks and allows regularly offer customers free updates. Now more than 2000 professionals are using Bio-Well devices worldwide, several hundreds papers are published [29], for 19 years international congresses in St. Petersburg, Russia, mostly dedicated to GDV technique and its applications, attract attention of scientists and researchers from many countries (www.sis-congress.com). Russian Ministry of Sport accepted GDV as one of the key technologies for testing athletes of Olympic and Paralympic teams. This opens up perspectives for using Bio-Well instrument for many practical applications and scientific research.

CONFLICT OF INTEREST

The author confirms that this article content has no conflict of interest.

REFERENCES

1. Korotkov K.G. The Energy of Consciousness. 2012. 220 p. Amazon.com Publishing.
2. Konikiewicz L.W., Griff L.C. Bioelectrography – A new method for detecting cancer and body physiology. Harrisburg: Leonard Associates Press, 1982. 240 p.
3. Jakovleva E., Korotkov K. Electrophotonic Analysis in Medicine. GDV Bioelectrography research. 2012. 160 p. Amazon.com Publishing.
4. Kostyuk N., Cole P., Meghanathan N., Isokpehi R., Cohly H, "GDV: an Imaging and Modelling Tool for Medical Bometrics, International Journal of Biomedical Imaging. February 2011.
5. Szadkowska I. , Masajtis J., Gosh J.H. Images of corona discharges in patients with cardiovascular diseases as a preliminary analysis for research of the influence of textiles on images of corona discharges in textiles' users. Autex research journal, 2010. v l. 10, n 1, pp 26-30.
6. Korotkov K. Science of Measuring Energy Fields. A Revolutionary Technique to Visualize Energy Fields of Humans and Nature. In: Bioelectromagnetic and Subtle Energy Medicine. Paul Rosh (ed). CRC Press, London, New York, 2015, pp 111-121.
7. Korotkov K., Korotkin D. Concentration dependence of gas discharge around drops of inorganic electrolytes. J of Applied Physics, 2001, 89, 9, 4732-4737.
8. Aleksandrova EV., Kovelkova TN. , Strychkov P V., Yakovleva E G. , Korotkov K G.. Electrophotonic Analysis of Arterial Hypertension. J of Science of Healing Outcome. 2015, 7, 28, 4-12.
9. Yakovleva E G., Buntseva OA, Belonosov SS, Feorov ED, Korotkov KG, and Zarubina TV. Identifying Patients with Colon Neoplasias with Gas Discharge Visualization Technique. The Journal Of Alternative And Complementary Medicine. 2015, 21, 11, 720–724 .
10. Drozdovski A, Gromova I, Korotkov K, Shelkov O, Akinnagbe F. Express-evaluation of the psycho-physiological condition of Paralympic athletes. Open Access Journal of Sports Medicine. 2012, 3, 215-222.
11. Korotkov K G.. Electrophotonic Analysis of Complex Parameters of the Environment and Psycho-Emotional State of a Person, WISE Journal. V 4, N 3, 2015, pp 49-56.
12. Korotkov K., De Vito D., Arem K., Madappa K., Williams B., Wisneski L. Healing Experiments Assessed with Electrophotonic Camera. Subtle Energies & Energy Medicine. 2010, 20, 3, 1- 15,.
13. Korotkov K, Orlov D. Analysis of Stimulated Electrophotonic Glow of Liquids. www.WaterJournal.org V 2, 2010.
14. Korotkov K., Krizhanovsky E., Borisova M., Hayes M., Matravers P., Momoh K.S., Peterson P., Shiozawa K., and Vainshelboim A. The Research of the Time Dynamics of the Gas Discharge Around Drops of Liquids. J of Applied Physics., 2007, v. 95, N 7, pp. 3334

15. Vainshelboim A.L., Hayes M.T., Momoh K.S. Bioelectrographic Testing of Mineral Samples: A Comparison of Techniques. J of Alternative and Complementary Medicine. 2005: Vol. 11, No. 2, pp. 299-304.
16. Ciesielska I.L., Masajtis J. The influence of textiles on corona discharge created around a human fingertip. Fibers & Textiles in Eastern Europe. 2007, v. 15, N. 5 – 6, pp 64 – 65.
17. Mandel P. Energy Emission Analysis; New Application of Kirlian Photography for Holistic Medicine. Synthesis Publishing Co., Germany. 1986.
18. Berdichevski M., Budnikov E. Method of analysis of vegetovascular crises. Patent SU 935076, 1982.
19. Belomestnich N.V., Zirjanova E.T., Primachenko N.J. Method of analysis of osteochondrosis of the cervical part of spine Patent SU, A3, 1812965, 1984.
20. Reznikov M.A. Method of diagnostics of the human organism state. Patent SU, 94012892, 1996 .
21. Herbepin P., Canetos J., Reynes J-L. Method and installation for dertermining the physical properties of an object Patent US 20030095316, 2000.
22. Korotkov K.G. Method for determination the anxiety level of a human being. Patent US 7869636, 2011.
23. Korotkov K.G. Method for determining the condition of a biological object and device for making same. Patent US 8321010, 2012.
24. Korotkov K.G. Method for determining hair conditions. Patent US 7595868, 2009.
25. Korotkov K.G. Device for measuring electromagnetic field intensity. Patent US 9075093 B2, 2015.
26. Borisova M.V., Yusubov R.R., Yanovskaya E.E. Application of GDV technique in predicting earthquakes. Proceedings of the XIX Congress "Science, Information, Spirit". St. Petersburg, 2015. www.sis-congress.com. Accessed 09.21.15.
27. Korotkov K. Non-local Consciousness Influence to Physical Sensors: Experimental Data. Philosophy Study, ISSN 2159-5313 September 2011, Vol. 1, No. 4, 295-304
28. Korotkov K., De Vito D., Arem K., Madappa K., Williams B., Wisneski L. Healing Experiments Assessed with Electrophotonic Camera. Subtle Energies & Energy Medicine • V 20, N 3, pp 1- 15, 2010.
29. Jakovleva E., Korotkov K. Electrophotonic Analysis in Medicine. GDV Bioelectrography research. 2012. 160 p. Amazon.com Publishing.