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REVIEW OF VIBRAIMAGE TECHNOLOGY APPLICATIONS

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Abstract: *A review of various vibraimage technology applications has been carried out. Variants of classification of vibraimage systems applications are proposed. The analysis of the literature on various vibraimage applications was done. The advantages and disadvantages of the main vibraimage applications are analyzed. Suggested the forecast for vibraimage updates and future developments.*

Keywords: *vibraimage, video, psychophysiology, security systems, applications.*

Since its inception, the vibraimage technology [Minkin, Shtam, 2000; Minkin, 2017] has found application in various fields of science, technology and practical life. Vibraimage technology is video image processing method that identifies features of vibrations and movements of exploring objects. Vibraimage allows to open some hidden properties in studied objects, regardless whether these objects are living or non-living physical objects. Relatively close analogues of vibraimage are thermal image or x-ray image of objects. However, thermal and X-ray images require special photodetectors of a special spectral range, while the vibraimage can be obtained from any video image, including black-and-white, color, thermal, or X-ray. The abundance of different vibraimage applications requires a certain systematization, at least to determine the limits of the capabilities of this technology. In this review, I will focus on practical implementations of the vibraimage technology, which have already found application in various fields.

1. Methods of classification for vibraimage technology applications

The basic principle of classification for vibraimage technology applications is the classification according to the type of object under study. It can be a live object (people, animals), a biological object (plants, seeds, blood...) or a non-live physical object (cars, bridges, pipes, crystals...). The next principle of classification for vibraimage technology applications is the classification according to the capturing information method from a stationary camera connected to a computer or a standalone mobile device, for example, a mobile phone.

Also is possible to classify vibraimage technology applications, based on the locality or globality of used system, such as a local computer, or a computer network

that transmits the data and processes the results on the server. The aim of this study limited by the vibraimage applications classification of exploring object.

2. Review of live objects vibraimage applications

The first vibraimages were obtained during observing various parts of the human body [Minkin, Shtam, 2000] and, of course, the person is the most interesting object of research. The number of different applications of vibraimage technology devoted to a person exceeds the number of all other vibraimage applications.

2.1. Human vibraimage

Security systems

The first practical task that was put before the vibraimage technology was to develop a system of contactless detection of suspicious and potentially dangerous people [Minkin, 2017]. For more than 10 years of developments and deliveries, several thousands of such systems have been manufactured, which successfully accomplish the goals at airports, train stations and other protected objects [Anisimova, Biragov, 2008; Minkin, Tseluiko, 2014]. The most significant event for this application was using of the vibraimage system to monitor all visitors on Sochi Olympics and identify suspicious, potentially dangerous and aggressive visitors [Minkin, Tseluiko, 2014]. Currently, vibraimage systems used 3 basic modes of suspicious and potentially dangerous people detection: Micro, Macro and Mix [Vibraimage PRO, 2019]. Micro mode is focused on monitoring people standing in one place for at least 10 seconds and provides the highest accuracy ($2\% < \text{FRR} < 10\%$) [Vibraimage PRO, 2019] with proper control organization. Mix mode is designed to control people standing in a line or slow-moving people and ensures accuracy ($8\% < \text{FRR} < 15\%$) [Vibraimage PRO, 2019]. Macro mode is focused on the most rapid assessment of people behavior in the crowd, it is not as accurate as the Micro and Mix modes, but it allows to evaluate the behavior of a person who is in the frame only 2–5 seconds with an accuracy ($10\% < \text{FRR} < 20\%$) [Vibraimage PRO, 2019].

Psychophysiological detection of deception

The vibraimage system is focused on psychophysiological lie detection as contactless polygraph [Minkin, 2009; Vibraimage PRO, 2019; Choi, 2018]. The main advantage of the vibraimage systems in relation to the polygraph is the possibility of contactless control, a relative disadvantage is the need to maintain a stable illumination of a testee. The accuracy of vibraimage systems during psychophysiological lie detection is comparable to a contact polygraph, however, the test time of a testee is reduced due to larger information content of vibraimage [Choi, 2018, Minkin, 2018].

Interviews, HR, recruiting, loyalty detection, psychological surveys, determination of abilities, self-tests, vocational guidance, etc.

The information content of vibraimage signals and the proven possibility of additivity of conscious and unconscious responses allows [Minkin, 2019] in a short (3–7) minute test, to determine the multiple intelligence profile [Minkin, Nikolaenko; 2017], psychological personality accentuation [Blank et al., 2018], compatibility [Minkin, 2012] or many other characteristics of a person, the identification of which requires hours when conducting similar studies by the other methods.

Medical diagnostics

Studies have shown that vibraimage technology makes possible to diagnose a wide range of diseases, moreover, at an early stage of their development [Blank et al., 2012]. The vestibular-emotional reflex [Minkin, Nikolaenko, 2008] creates a characteristic motor imprint for each pathology, similar to biochemical analysis. For said motor imprint detection is necessary to conduct standard medical studies of the control group and patient groups. For medical applications, the vibraimage technology should be considered as an express diagnostic, since the speed of obtaining result exceeds the majority of used analogs.

Psychophysiological preshift testing

This application is increasingly important, as the development of technologies increase the importance of the human factor as one of the most significant risks of man-made disasters. One-minute pre-shift testing by the vibraimage system [VibraStaff, 2019] of operators at nuclear power plants [Bobrov, Shcheblanov, 2018], air traffic controllers and other specialists [Schelkanova, 2018] can significantly reduce the risk of inadequate personnel actions in critical situations and prevent staff from working in inadequate condition.

Vibraimage sport applications

One of the main problems of modern sport is the lack of operational and contactless methods of controlling the overtraining of athletes. It is also known that the psychological attitude of an athlete before a game has a great importance for obtaining the ultimate result. For team sports, team compatibility, the optimal choice of starting staff, operational control over changes in the psychophysiological state during the game and the correctness of substitutions during the game are also very important. Vibraimage technology is used to solve the listed problems [Lutkova et al., 2019] and psychophysiological control in training of athletes will undoubtedly develop in a near future.

Vibraimage as a tool for the science study of personal characteristics

Recently, a number of studies aimed at studying various characteristics of a person's personality have been carried out, in which vibraimage technology performs a key role [Minkin, Nikolaenko, 2017; Minkin, Myasnikova, 2018; Minkin, Blank, 2019]. The unique capabilities of the vibraimage technology, which allow combining the simultaneous study of conscious and unconscious responses, allows to reveal new properties of a personality and contribute to the development of new vibraimage applications. The obtained science results are used in testing of multiple intelligence, psychological accentuations, medical diagnostics, lie detection, interviewing, and can be used with any technology of psychological and psychophysiological testing.

2.2. Vibraimage of animals

At present, these applications are only gaining, although in a future in terms of volume they can seriously compete with applications based on human vibraimage. People can exchange verbal information, and vibraimage technology is used mainly to obtain hidden information about a person. But the animal cannot say anything to the owner, and the vibraimage technology can simplify the communication of man and animal. Moreover, the sources of the vibraimage technology were certainly laid by Darwin [Darwin, 1873] and Lorentz [Lorenz, 1966], who firstly analyzed the behavior of animals and then transferred the findings to humans. Therefore, the use of vibraimage in veterinary medicine and animal behavior should be more developed in the near future.

2.3. Vibraimage of biological objects

I refer biological objects to organic objects that have own mobility (living cells, blood, fluids), which can be observed with an increase by a microscope, as well as objects with little or no mobility (seeds, leaves, plant parts), the vibraimage of which is mostly determined mechanical features of an edge and the contrast of the object relative to the background. Even if the studies are seemingly low informative, but should not be skeptical of the statistical results obtained if it shows significant differences between different types of biological objects [Zanco, 2016; Venture et al, 2017], since the internal biochemical composition has an impact on those physical characteristics (color, weight, contrast, shape of the edge), which reveals by vibraimage. Therefore, vibraimage can be a rather technological way of detecting genetically modified products, due to the influence of aggregate physical features, on vibraimage characteristics [Zanco, 2016].

2.4. Vibraimage of non-living objects

Since almost all the physical objects in our world have vibrations or movements, one can observe the vibraimage of almost any object. The availability and quality of the vibraimage depends primarily on the means of observation. Naturally, standard television cameras should be used to observe objects with large vibrations, such as

a running car engine or bridge vibrations, while a microscope can be used to record the vibrations of bridge supports. At the same time, for non-living objects (as well as for living), vibraimage allows you to calculate and use not only periodic movements, but also macro-movements, for example, used to traffic control [NikeiBP, 2017]. Another possible way to use vibraimage is to predict earthquakes and control seismic activity [VibraEarth, 2016]. The possibility of informative using of vibraimage in astronomy and remote sensing of the earth is not excluded, since the accumulation of information about remote macro objects may exceed by some qualities the traditional methods of their observation.

2.5. Mystical events observation

The fact that the vibraimage is a purely technical and physical technology for measuring the characteristics of the mechanical movements of an object allows to visualize phenomena that do not always have current scientific explanation. In this case, special attention should be paid to the conditions of the experiment (I repeat that any object has vibrations, their visualization depends only on the means of observation) and conclusions that are made on the basis of the data obtained. The vibraimage technology, by virtue of mathematical formulas embedded in it, with high sensitivity reveals periodic and stochastic vibrations in any movement, and changes in vibrations may indicate various changes in the state of the object, which may not always be as significant by other physical methods. The high sensitivity to state changes that attracts researchers involved in the study of various unexplained phenomena [Debertolis, Gulla, 2017].

All results obtained by the vibraimage system have a clear physical meaning, since the vibraimage system registers only physical phenomena. Proper organization of the experiment and strict adherence to the recommendations for using allows researchers to draw correct conclusions from the obtained results.

3. Discussion

This review is the second after the study [Minkin, 2007], which describes the various applications of vibraimage systems. Naturally, over the time since the first publication, the number of practically used applications has slightly increased. The work [Minkin, 2018] analyzed the reasons for slow development of the vibraimage technology. Most of the new applications were proposed by the vibraimage systems users obtained new results that extend the capabilities of existing programs. Most likely, such a trend will prolong in the future, if the existing business model of Elsys — Partners cooperation does not change. At the moment, the developers of the vibraimage system (Elsys company) are mainly focused on the technical support of partners, the achievement of better technical results (increase in speed, reduction in processor load, increase in accuracy, development of new platforms, etc.), which requires significant resources of Elsys [Minkin, 2018]. However, the rate of applications development can be significantly increased with the emergence of a global business investor who can combine the development of all areas within one company.

Conclusions

Since the first patent has been filed [Minkin, Shtam, 2000], the vibraimage technology is slowly but surely developing in different directions. Whether this vibraimage technology development will be a breakthrough and mass apply will be clear in the next few years. While vibraimage technical properties (contactless, informational content of the vestibular-emotional reflex, easy and friendly information processing) provides an advantage over other technologies of psychophysiological detection.

However, technical progress does not stand still. Most likely, if a breakthrough to mass applications is not made in the next 10 years, powerful competitors will emerge. Perhaps this will be the technology of using reflected electromagnetic waves [Zhao et al., 2016], which are beginning to be used for psychophysiological detection, and perhaps something fundamentally new and unknown will appear. The Greek philosopher Protagoras claimed that man is the measure of all things. Therefore, the study of man as an object will always be the main goal of science, and the technology of vibraimage is important step in its study.

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