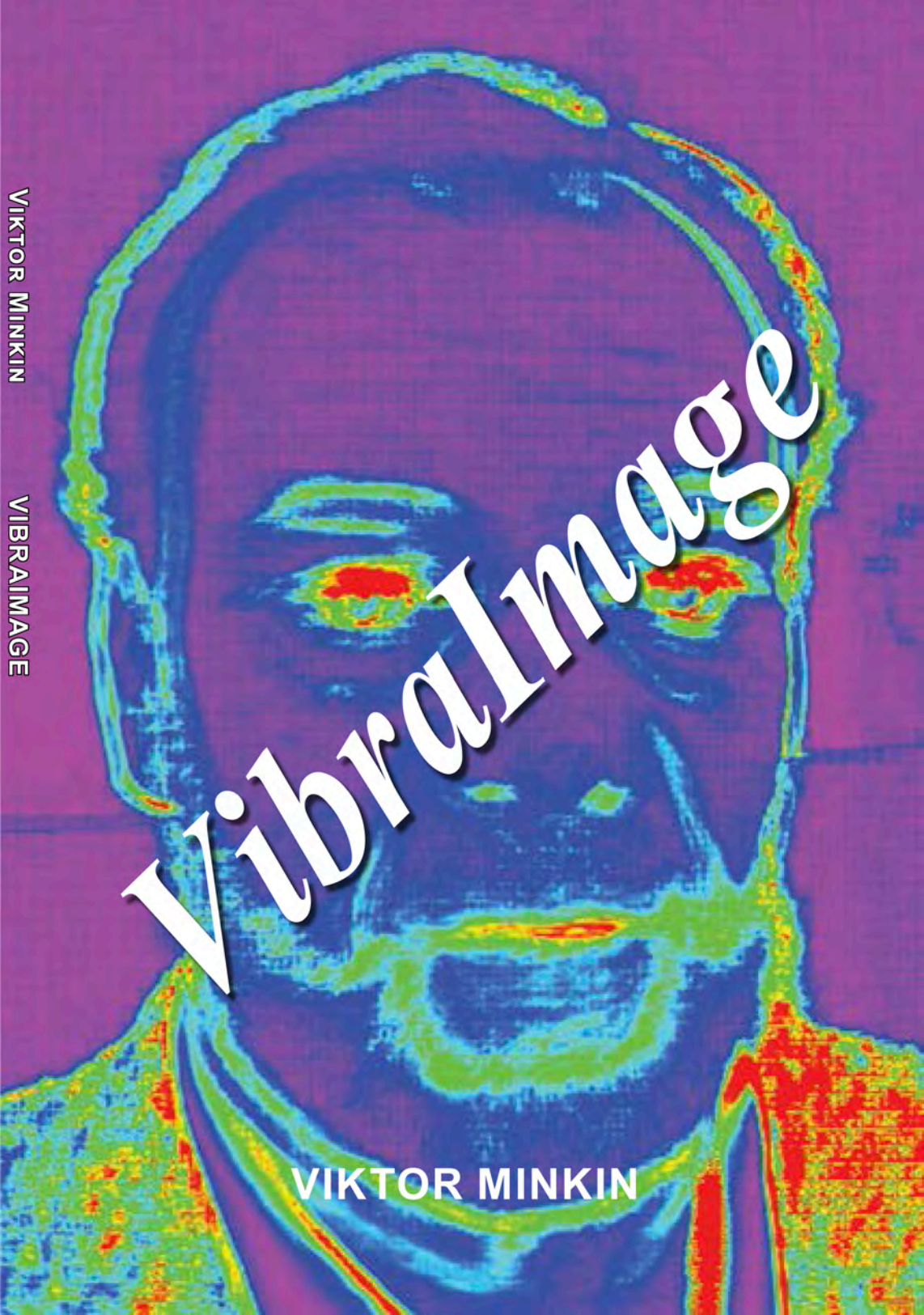
VibraImage
VIKTOR MINKIN
VIKTOR MINKIN
VIBRAIMAGE

Viktor Minkin

VibraImage

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The monograph presents the results of the study and application of a physically primary type of image, a vibraimage, which displays the speed of change (vibration parameters) for each video image pixel. Vibraimage informatively visualizes micro movement and vibration parameters of a quasi-stationary object. The principles and methods of obtaining a real vibraimage of an object have been developed and presented. It is argued that by means of vibraimage parameters it is possible to characterize the psychophysiological state of humans and animals. Calculation formulas and equations of various emotional states of a person to measure the levels of aggression, stress and anxiety are set out. Recommendations on psychophysiological and psycho-emotional diagnostics of a person's state, based on vibraimage parameters, are provided.

The monograph is intended for specialists in psychophysiology, psychology, physiology, security, medicine and biometrics, as well as for a wide range of readers interested in computer aided techniques and virtual reality technologies of a person's psychophysiological state diagnostics, and working with the VibraImage system.

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INTRODUCTION
TO THE ENGLISH EDITION, 2017

It so happened that the publication of the English edition of the book *Vibraimage* has become necessary only 10 years after the book was issued in the Russian language in the year 2007. As the Russian edition of the *Vibraimage* book was written about 10 years after the beginning of the vibraimage technology development and capturing of the first vibraimages dated back to the year 1997. It turns out that this edition summarizes about 20 years of the development, and scientific and experimental research of the vibraimage technology. Since the first edition of the book was written at the halfway stage, it is necessary, at least in this introduction, to add a brief report on what happened to vibraimage technology after the publication of the first monograph. It is interesting to the author to see which of his forecasts came true 10 years later. Perhaps, it would be better to revise the text of the book for this edition, and to present the basics of the technology from the contemporary perspective, but the rewriting of history causes so much disgust that the author prefers to keep the main text of the original edition, especially since the basics of vibraimage technology have not changed much over the last 10 years.

On the one hand, for information technologies, the vibraimage technology being one of them, 10 years is a huge period of time. But, on the other hand, for psychophysiological technologies, the vibraimage technology certainly also being one of them, a ten years' time period is nothing. The works on Physics and Metaphysics written by Aristotle about 2,500 years ago, concerning the reasoning on human nature are

still relevant today; and the personality and temperaments typology proposed by Hippocrates approximately 100 years before the works of Aristotle is the basis of most of modern psychological and psychophysiological classifications. All technologies related to studying of personality and human behavior are not expanding as fast as classic information technologies based only on technical and physical principles of work. Perhaps this is the reason for a certain slowness of vibraimage technology development (most likely this objective slowness of the psychophysiological technologies development was not considered in Google, and they managed during the same time period to open the Google Glass project and quickly to shut it down, having spent considerable funds), though along with the objective reasons for this slowness, for certain, there is also a number of the subjective reasons that impede rapid development of this technology.

One of these subjective reasons is Russian origin of vibraimage technology and a small number of English language publications on the topic. I hope that the publication of the book *Vibraimage* in English will change the situation as the interest in the vibraimage technology increases every year worldwide despite the small number of English-language publications. Moreover, immediately following the publication of this book the next work *Vibraimage and Multiple Intelligences* will be published in English, and the difference between Russian and English editions will make not 10 years, but only several months.

What remarkable things happened to vibraimage technology (or simply vibra) over the last 10 years? Moreover, the Elsys' team carries out the updating of the professional version of the Vibraimage PRO program if not daily, then at least two times a week; therefore, the number of program technical updates during this period exceeded 1000 versions. However, largely,

there are not a lot of significant changes in the programs; every significant change is achieved with sweat and blood, and revising global theories and psychophysiological concepts.

Almost immediately after the release of the monograph it was revealed that the main reason for vibraimage of a person is the vestibular-emotional reflex [1]. The existence of such acquired reflex linking the psychophysiological state of a person with the work of the neck muscles allows considering vibraimage the same physiological parameter of a person as galvanic skin response, heart rate or arterial pressure. At the same time, the informative value of vibraimage is higher than of other physiological signals due to the fact that the reflex work of the neck muscles to maintain the head in the vertical position is controlled by the vestibular system, and it is more sensitive to any deviations from equilibrium (including emotional balance deviations) than other physiological systems of a person, such as skin, cardiovascular, respiratory systems, etc. Physical understanding of the physiological factors determining psychophysiological informative value of vibraimage is necessary to increase the accuracy in determining and assessment of the parameters of a person's psychophysiological state. It is known from metrology that only understanding the nature of a measured physical value changing, it is possible to achieve maximum accuracy and minimum measurement error. It is pointless to attempt to measure AC voltage with a voltmeter for DC. Therefore, understanding the initial physical and physiological processes occurring in the human body allows their decoding, and identifying emotions, mood, illness, and even person minds by analyzing micromovements of his head. The resulting understanding of the fact that what is recorded is not a miracle, but a normal physiological reflex, requires the introduction of the phenomenon as one of the significant achievements for vibraimage technology team over the last

10 years. The founder of modern cybernetics, Norbert Wiener, wrote [2] that “There are fields of scientific work, as we shall see in the body of this book, which have been explored from the different sides of pure mathematics, statistics, electrical engineering and neurophysiology”…“It is these boundary regions of science which offer the richest opportunities to the qualified investigator.” Combining knowledge from different sciences into an integrated product presents a significant difficulty for any team. Wiener complained that in the year 1948 “Since Leibniz …science has been increasingly the task of specialists, in the fields which show a tendency to grow progressively narrower” and now there are no more such broad minded, high-level scientists like Gauss, Faraday and Darwin, who lived in the 19th century. Nowadays it is regrettable, that there are no such great figures of the 20th century as Wiener, Shannon, Pavlov and Bernstein [3] who could unify various sciences and views into a single theory and a practical solution. At the same time, in the author’s opinion, the vibraimage technology is one of the few 21st century technologies, which successfully unifies such diverse sciences in one practical solution. However, this broad scope of vibraimage applications and different science knowledge are also a certain hindrance to fast technology development, as it does not allow focusing the efforts on developing the product in one scientific and practical area.

The next significant step in the development of vibraimage technology, which has already been reflected in the program, was the revision of the approach to the determination of the current psychophysiological state of a person. Historically, practically all informative physiological signals were obtained in the form of time dependencies, for example, the electrocardiogram, the encephalogram, the signals from lie detector sensors, etc. It is natural that when developing the first Vibraimage systems similar technique was used;

time dependences of vibraimage signals were created and analyzed — amplitude, frequency, parameters of symmetry and processing. However, long-term experiments and the search of the parameters of efficient display of a person psycho-physiological state showed that the most informative is the display of a psychophysiological state in information-energy scales. Intuitively, this inference was made in the conclusion of this monograph in the year 2007. The consistent development of information-energy approach to the determination of a psychophysiological state of a person took place up to the present time in many publications [4, 5, 6, 7] which develop the scientific basis for this approach, although the information-energy (psycho-energy) diagram of psychophysiological state changes was present in earlier versions of the program as well. Perhaps, the event does no credit to the author and the developer of the technology, as the majority of the results obtained in vibraimage technology, first is observed experimentally and only then finds its theoretical grounding. But each person has their own specific advantages and disadvantages. The abilities of a person also can be determined with the help of vibraimage technology; these experiments on myself and others will be described in the following monograph [8]. Regarding the information-energy diagram representing psychophysiological state, its applicability considerably increases in the latest versions of vibraimage programs, especially in the applications concerning lie detection and psychological testing. It should be noted that the transition to the information-energy diagram determining the psychophysiological state opens new ways to the study of consciousness, behavior and personality not only for vibraimage technology but also for other psychophysiological technologies.

Perhaps, these two main research areas guided the scientific development of vibraimage technology over the last 10 years. At the same time, there was carried out a large

number of applied researches and developments relating to various applications of vibraimage technology, first of all in medicine [9], applications for mobile phones [6] and scientific studies of a psychophysiological state of a person [10]. In addition to Vibraimage PRO version were developed different single programs for concrete applications as VibraMI (intellect profile testing), VibraStaff (pre-shift operator testing), VibraMED (medical diagnostics), VibraMID (security checking), VibraLie+ (lie detection and psychology testing), Love Detector (mobile phone users compatibility testing). For the purpose of the scientific research, under the interface of one program the combining of vibraimage, an electroencephalograph, pulsometry, and mobile phone sensors (accelerometers, gyroscopes, MEMS) signals were carried out. That allowed investigating the interrelation of mechanical vibrations of person head with the work of other physiological systems, and obtaining one powerful tool for carrying out scientific investigations of various psychophysiological states. Besides, in the program there was a new tab that allows estimating the cross-correlation of the signals under study. This concerns not only the signals and parameters of vibraimage but also the signals obtained from external devices. This approach allowed to verify experimentally that mechanical vibrations and motion parameters can be determined by various methods, and to measure practically the correlation in work of various human physiological systems.

For the time elapsed since the issue of the first monograph the main practical achievements of Vibraimage systems are certainly related to the use of vibraimage in security systems. The biggest project was the use of Vibraimage systems for monitoring of all visitors, identification of potentially dangerous individuals and suspicious persons during the Olympic Games in Sochi in 2014. Vibraimage systems, in the scale of application (about 250 systems and places of monitoring united in one

network), surpassed all currently known analogs, and showed good accuracy (above 90 %) in identifying a psychophysiological state of visitors. According to the obtained data the probability of errors in identification of potentially dangerous visitors, when monitoring about 3 million visitors, made FAR = 0, FRR < 10 % [11]. Moreover, the time of monitoring of one person did not exceed 10 seconds; it was a remote, contactless control, and for the visitors it was no different from the work of conventional video surveillance systems. While preparing for the Olympic Games a considerable preparatory work on the installation and maintenance of Vibraimage systems, and the personnel training was carried out. The maintenance of Vibraimage systems in Sochi was done by the personnel consisting of about 1000 people; however, their training took no more than a month.

The practical use of Vibraimage system as a means of technical profiling showed its high efficiency since the system maintenance is simple and clear, and, unlike the control held by a person, the result of monitoring is objective and stable. It should be particularly noted that the task of the Vibraimage system, and of any other system of technical profiling, is primarily to narrow the flow of suspects for careful monitoring but not to exclude a psychologist-profiler from monitoring process. This approach allows using efficiently Vibraimage systems to identify potentially dangerous persons in security systems. At the same time, the obligatory regulations defining the personnel actions in case of detection of a potentially dangerous person should be developed. The second stage of behavioral monitoring of such a person can be also carried out using Vibraimage systems, but careful control of the revealed person can be carried out in a special place and for a longer time which does not create hindrances for the main flow of people.

The maintenance of Vibraimage systems to identify potentially dangerous people in secure facilities showed that the efficiency of this system largely depends on its proper installation, and the design of the facility according to the requirements for Vibraimage systems installing. For the Olympic Games in Sochi a typical design of the pavilion to monitor the visitors had been worked out which allowed using the standard settings of the Vibraimage system practically in all the areas of monitoring.

The most common mistake of the Vibraimage system users is its standard settings use in conditions requiring the use of specific individual settings that need to be develop for specific conditions of application. Practice has shown that it is possible to use Vibraimage system to identify the suspects in very difficult conditions if the settings of the system are carried out correctly. For educating and training users a special program has been elaborated and the user certificate system has been introduced.

It is difficult for the author to estimate his creation. In my opinion, like all twenty-year-olds, vibraimage technology is rather young, full of energy and plans for the future. I hope that vibraimage technology could become a global technology that will change the world for the better. For this purpose, it has certain potentialities and opportunities. To make it happen it is necessary for the composite authors, the Elsys Company, St. Petersburg, Russia, as well as for the numerous partners who are interested in the development of vibraimage technology in Russia and around the world to continue working at the technology. We could say that the technology and the program of vibraimage were born incidentally, no one ordered the author to develop this technology. But after Freud we know that nothing happens in the world by accident, words are not uttered by accident, and a person does not make movements

by accident. The users' requests to change the interface and to introduce additional functions to the program are also not accidental. The considerable part of these requests is being responded, and the current version of Vibraimage software has been created owing to our users and partners from the different countries.

As this is the preface to the English edition, I would like to thank first of all the foreign partners who contributed to the development of vibraimage technology around the world.

Acknowledgements

I begin by thanking our Korean partner, the president of Vibrasystem Company, Mr. Kwan Choi, an active and friendly companionship with whom has been going on for more than 12 years. His feedbacks on the elaboration of identification modes of suspicious people, mobile applications, systems and methods of psychophysiological lie detection have been reflected in our projects and certainly promoted the development of the vibraimage technology.

The vibraimage technology is not only an IT technology; it is a certain mindset. And the world outlook of Oriental people is somewhat different from the outlook of people in the West. I think that the interest in vibraimage technology and its greater development in the East are associated with the Oriental world outlook, and with the vigorous activity of Mr. Kwan Choi for promoting the vibraimage technology in various directions.

I express my deepest gratitude to our Japanese partner, the CEO of the Elsys-Japan Company, Mr. Hidetoshi Yamauchi for the practical implementation and promotion of Vibraimage systems and opening Japan for vibraimaging. I have a much better idea than others that a successful promotion of

Vibraimage systems requires from a person the combination of several traits, only financial or technical capabilities are not enough for this purpose. The vigorous activity of Mr. Yamauchi-san allowed combining the efforts of many forces in implementing the complex projects, for example, security providing at the G7 meeting in Japan, 2016, by means of the vibraimage technology.

Nowadays the largest market in the world for any products is, of course, the Chinese market. It develops so rapidly that only few Western companies can successfully work in it. I am grateful to our Chinese partners, the President of the Taiyuan Kangqi Company, Mr. Gao Shuoxin, and the Executive Director Mrs. Chen Yu for mutual understanding and the adaptation of the technology to the conditions of the Chinese market.

If I could write detailed notes of acknowledgement to all our foreign partners, their amount would exceed the volume of this monograph. However, I still want to highlight the contribution to the advancement of the technology, made by the people who became the Elsys partners after the monograph was issued, including Leonid Gorsha and Eugeni Saenko (Ukraine), Andrea Tommesani (Italy), Martin Tseng (Taiwan), Michele Pes and Dr. Andtej Kalendarev (Germany), Ivan Ortega and Jim Cane (USA), Michael Berg (Canada), Zeev Rozenberg and Alec Weingart (Mongolia), Sharon Laskov (Israel), Tomaas Liiv (Estonia), Dr. Andrei Mikhin (Spain), Dr. Vaclav Jirovsky and Jan Tůma (Czech Republic), Alexander Vasiliev (UAE), Jim Stoddarts (GB), Patrick Tan (Singapore), Jasper Zanco (Brazil), Mukul Ghanekar (India).

I hope that the publication of the English edition of this book will facilitate the comprehension of vibraimage technology, and its widest possible dissemination throughout the world will allow successfully solving the tasks designated in the monograph.

Notes

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In memory of Jafe,
an English Cocker Spaniel

INTRODUCTION, 2007

This is the first monograph devoted to the vibraimage technology and the study of a person's vibraimage. Modern scientific achievements in various fields are connected with micro world analysis that allows identifying the common fundamental laws, which are true for macro world as well. The vibraimage technology measures and analyzes a person's micro movements. It can be called *nanopsychology* as it allows registering the shift of a person's gravity center with an accuracy of a few nanometers; and it allows investigating behavior and a person's psychophysiological state similarly to classical psychology.

The technical task to identify the psychophysiological state of a person is referred to biometrics. Biometrics combines physics, mathematics, medicine and psychology for measuring biological and/or behavioral characteristics of a person for the purpose of identification, and in order to identify a person's psychophysiological state.

Biometrics has recently become widely known, first, due to the technologies of person identification and biometric passports. However, biometric identification technologies originated long before the rise of humanity because the abilities to recognize or identify objects and states are inherent and necessary in any species.

Moreover, from evolution theory perspective, any species unable to discern psychophysiological state of another specimen of the type is doomed to extinction.

On the other hand, the vibraimage technology is a brand new and modern technology, and its technical implementation has become possible only in the 21st century due to the development of modern computer technology and electronics. The entire technical power of modern science explains only a part of the secrets and laws that determine the behavior of living beings; and currently existing technologies for obtaining a person's informative image (ultrasonography, NMR, EEG and others) display certain physical properties of a subject. The author considers that a vibraimage is a new physical image, which informatively displays a person's psychophysiological parameters, and invites the reader to take a step forward in the study of this phenomenon.

This book may be of interest to specialists in the field of psychology, psychophysiology, biometrics and medicine, as well as to the researchers working with *VibraImage system*.

The monograph summarizes the intermediate result of many years of biometric development at ELSYS Corp, (Saint Petersburg, Russia), and the works on implementation of the Russian State contract № 02.435.11.6002 of June 23, 2005 in the framework of the Federal targeted scientific and technical program '*The Research and Development on Priority Directions of Science and Technology'* for the years 2002–2006 for the priority area 'Security and Counterterrorism' (the 3d turn), Lot # 1. BT — 13.2/003, '*Establishing a System of Remote Contactless Scanning and Identification of the Psychophysiological State of a Person'.*

The author expresses his utmost gratitude and deep appreciation to Tatiana Didenko, the main assistant in the vibraimage study, and the editor of this book, as well as to the entire ELSYS team working on the development of this technology, especially to Alexander Shtam, the co-author of

the technology, Lyudmila Romanova, the Director of ELSYS, and Valeriy Akimov, the software engineer.

Special thanks to Alexander Kashirin, Vagif Sultanov (Australia) and Niky Klipper (Israel) for their substantial assistance and support in advancing the vibraimage technology.

I benefited greatly from communicating with Professor Revold Ivanovich Polonnikov, from his critical remarks and his books. His concept of the General information theory had a significant impact on this work.

I thank Professor Goergy Gladyshev and Libb Thims (USA) who showed the possibility to explain the vibraimage effect based on chemistry and thermodynamics. I also want to thank Nikolay Nikolaevich Nikolayenko, Doctor of Medical Science, for his instructive experiments conducted on the comparative testing of the EEG and vibraimage technologies; and also for his interesting ideas on the association of hemispheric asymmetry of brain activity with vibrations and micro-movements of a person.

1. PSYCHOPHYSIOLOGY AND EMOTIONS

Human behavior and emotions have always been of interest to scientists. It is believed that Charles Darwin's book *The Expression of the Emotions in Man and Animals* [1], first published in 1872, marked the beginning of scientific study of the world of human emotions.

However, the work of the Great Russian physiologist Ivan Mikhailovich Sechenov, *Reflexes of the Brain* [2], was published even earlier, in the year 1863, and really ushered in an era of objective psychophysiology. The main thesis of this work — "all the external manifestations of brain activity can be reduced to muscular movement" — remains absolutely relevant today.

Moreover, the objectivity of this thesis can be fully realized only now, when there has appeared a vibraimage technology that enables the use of technical means to carry out quantitative and qualitative analysis of tiny muscle movements and displacements. The founder of analytical psychology S. Freud also argued about the existence of the indissoluble link between human psyche, physiology, and energy [3]; though the mechanism of this connection still has not been defined; and there are many different approaches and theories on its definition. The attempts at quantitative analysis of a person's movements to analyze the emotional state had been taken previously. One of the most renowned experts in the study of aggression in the twentieth century, the Nobel Prize winner, Konrad Lorenz argued that there is an inextricable link between the physical activity of animals and the level of aggression [4]. Brazilian psychologist E. Mira y López offered a real miokinetic diagnostic technique, which is widely used in general and clinical

psychology, and in personality psychology [5]. Unfortunately, the miokinetic diagnostic technique is manual, laborious and time-consuming. It requires the manual processing of results, which significantly limits its application.

Currently there have been carried out a great number of various psychophysiological researches on defining the parameters and techniques which informatively describe a person's state [6, 7], including those on the movements of eyes and the head [8]. The classic monograph by H. Tamar [9] sets out in sufficient detail the systematic knowledge on sensory physiology, emphasizing particularly the issue of inhibition in sensory systems and neurophysiology.

The information theory of emotions of academician P. V. Simonov [10] is inextricably linked with the systemic approach of Ivan Pavlov to the study of the higher nervous (psychic) activity. It is productive for the analysis of emotions psychology and for studying the brain mechanisms of reactions of humans and animals, and it offers common approaches and formulas for quantification of emotions.

General information theory of Professor R. I. Polonnikov [11, 12] considers the measurement of psychophysiological parameters of a person as a typical biometric task of the third generation, and any biological object as a complex system of receiving and processing information.

The Hierarchical thermodynamics of Professor G. P. Gladyshev [13] and Human Thermodynamics of L. Thims [14] investigate and analyze objects (including human beings) in equilibrium state by means of the basic physical laws — the first and second laws of thermodynamics.

The present vibraimage method reveals the existing psychophysical phenomenon, in a varying degree reflecting the listed scientific theories revised by the author to create a working version of the system for remote contactless scanning and identification of a person's psychophysiological state.

2. IMAGE TYPES

In order to answer the question ‘what is a vibraimage?’ we shall define what an image is. There are many different definitions of the term image, for example, the image is how we see the world. The most general definition of an image is the following: the image is a visual display of data (http://en.wikipedia.org/wiki/Image). The color image that we see depends not only on the properties of an object. It is a subjective function of our consciousness that transforms physical particles into visual images. It is known that color vision in birds is better developed than in humans [15]. Most mammals have lost much of their color perception in the period of evolution, when they were mainly nocturnal. Thus, the image perceived by a live object is always subjective. On the other hand, the optical image, habitual for us, is characterized by the properties of the light reflected from the objects, i.e. a most usual subject can have an uncountable number of images visible to the eye, the changes in the spectral composition of light falling on the subject provided. Therefore, the normal color image (fig. 1) depends on the optical properties of an object, the properties of light falling on it, and the properties of a photodetector.

Can the image of an object not depend on what kind of light falls on it? Yes, it can, for instance, if it is a heat or thermal image. A thermal image (fig. 2) is determined by the temperature of an object but in order to see it you need a special thermal imaging photodetectors. A thermal imaging photodetector receives an object’s heat radiation and converts it into visible light following a certain algorithm.

Fig. 1. *Normal color image*

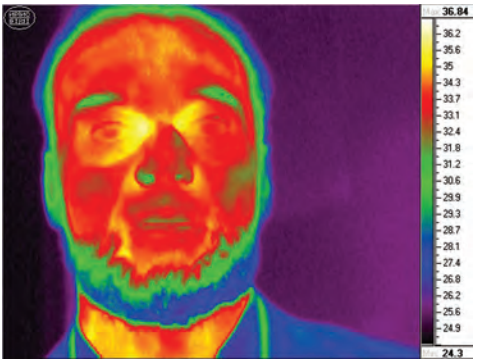


Fig. 2. *Thermal image*

Hence, the distribution of the physical properties of an object in space is transmitted through primary images, influenced by certain physical parameters or processes. Similarly the thermal image, x-ray image (fig. 3) displays the physical information about an object's transparency to x-rays.

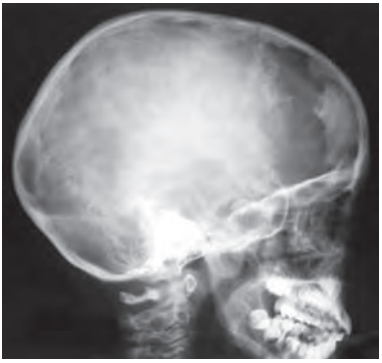


Fig. 3. *X-ray image*

There are many examples of image transmission or image encoding when we don't even think how the decoding takes place and what the initial image represents. For example, an image of a district map codes an object's height by means of color, and this text codes letters and words by means of symbols. All examples given above reflect static (i.e. constant in time) properties of objects.

And what if we try to define the image that characterizes the movement of an object, how can we do this? Everyone knows that for conventional photography the movement and the image are incompatible things. If the object is moving, the image will be blurry or will not work at all.

But velocity is the same property of an object as temperature. This means it is possible to create an image that shows the velocity of the object. And if an object does periodic movements then the image should be termed a vibraimage [16].

3. INHERENT VIBRATIONS OF BIOLOGICAL OBJECTS

The idea of a vibraimage has appeared rather incidentally, but not from scratch. Largely it has been facilitated by the work on biometric identification technology when determining the difference between a live biometric parameter and its fake.

Fingerprint Systems

While solving the task of protecting fingerprint systems from fake dactyloscopic image media (i.e. false fingerprints), in examining the pulse in fingertips it was found that blood pulsations in nearby points of a finger may differ significantly in amplitude, phase and frequency (fig. 4). Considering the pulse wave propagation velocity in vessels of a person is rather high and makes approximately 10 m/s. At this propagation velocity, it was assumed that the close-set (within a few tenths of millimeters) blood vessels and capillaries should pulse in the same manner. In fact, this proved not to be the case because the pulsation is also determined by the superposition and reflection of pulse waves from vascular walls and capillaries. This makes the process more complex and informative than it seems as a first approximation. In other words, we saw that all the points on the skin surface of a human finger make micro-movements relative to each other both in time and in space. Pulse waves run through a finger in three-dimensional space (fig. 5). The technology of visualization of this phenomenon was named 3d-pulse [17]. In order to record a picture of these movements, it was sufficient to track the time variation

of the magnitude of the signal characterizing transparency of a finger in a point or an average value of transparency in the area i.e. the blur, which prevents the formation of conventional photography. If you accumulate the magnitude of a signal change at each point, it is possible to form a new informative image, which reflects the vibration parameters of a given point. So the first vibraimage was obtained through fingerprint contact.

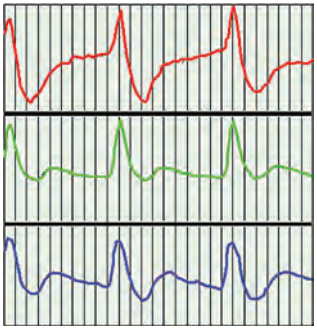


Fig. 4. *Pulse waves in three nearby points of a finger*

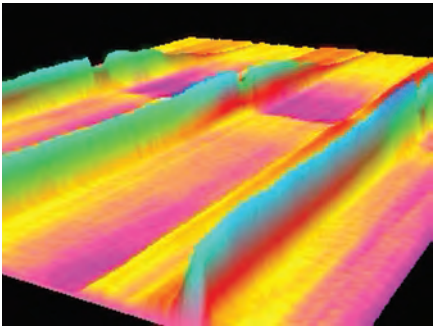


Fig. 5. *3d-pulse in a finger*

Animal Behavior

I don't know whether this technology would have been developed and this book would have been written should the author have had a different kind of dog, but not an English Cocker Spaniel. It is known that the English Cocker has the highest frequency of the wagging tail (among all breeds of dogs), and by the frequency and amplitude of tail wagging, the understanding master can define the mood of the dog absolutely precisely. The English Cocker is a hunting breed, and this function (the frequency of the wagging tail) is undoubtedly connected with a certain evolutionary development. The dog

has to signal the hunter about the coming prey, and voice alarm is impossible (otherwise the prey could be frightened away), and the dog should be prepared to attack (at stack). Most of his conclusions and observations about human emotions ingenious Darwin also checked and confirmed by observing the behavior of animals, primarily dogs [1]. But I guess he didn't have a Coker, therefore he based his observations on the external appearance of animals.

One of the most famous biologists and researchers of aggression, a Nobel Prize winner of the year 1973 on physiology and medicine, Konrad Lorenz, after long years of observing different types of animals claimed [4] that intraspecific aggression is one of natural and necessary factors of animal species evolution, and the one who will be able to determine the intensity and frequency of displacement of an animal, will be able to determine the level of aggressiveness. However, at that time it was impossible to normalize the detection of the amplitude and frequency of displacement. Unfortunately, as it often happens, the author read these works much later, when the first vibraimage had been obtained, and thus many things had to be rediscovered.

Observation over the frequency of the dog's tail movements was the very moment that determined the physiological meaningfulness of vibraimage and the informativeness of transition from vibraimage amplitude to frequency that is described in more detail in the following chapters of the book.

4. WHAT IS A VIBRAIMAGE

It is known that human livelihood and the life of any living object is based on a number of periodic processes (respiration, pulse, work of sensory systems) occurring in the body. The intensity of physiological processes is connected with the condition of an organism. When a person is calm and at rest his heart rate and respiration are minimal, when a person is excited his respiration and heart rate increase. Various oscillatory processes are characterized by two basic parameters — frequency and amplitude. Thus if it is possible to obtain the image of a person which shows the frequency and amplitude of the movement each of his points then this image shall reflect informatively the psycho-physiological state of a person in general. A vibraimage is the image, each point of which reflects spatial and temporal parameters of vibration and movement of an object.

The first vibraimage obtained [18] showed the amplitude of displacement of each point of a person's face and was perceived by the developers as a funny joke. It was interesting to see one's own face which is generally recognizable but is painted in strange colors with unclear meaning. Quite a lot of time had passed when examining my own or someone else's vibraimages I managed to notice interesting patterns of color change and the saturation of a picture. The next step, which now looks obvious, was to obtain a vibraimage showing the frequency and not the amplitude of vibration. It has become easier to analyze the images obtained since it turned out that it is the vibration frequency of a person, rather than the

amplitude, reflects the energy of a person's movement and therefore mental condition, emotions and health. Each point of a person makes displacements or vibrations with its own frequency and amplitude, and the visual analysis of such picture was rather difficult.

Figures 8 and 9 show the amplitude and vibrations frequency by means of one color scale which approximately coincides with the curve of the spectral sensitivity of a human eye [19]. The purple color corresponds there to the minimum value of the parameter, and the red color corresponds to the maximum value. It is obvious that both images are quite similar, since under certain conditions (but not always!), they show the relatively correlated movement parameters of the object (frequency and amplitude), and the present differences show different algorithm of calculation and different noise immunity of parameters.

In terms of its physical properties a vibraimage is primary, as well as other well-known images, for example, an ordinary color image of objects, a thermo-image or an x-ray image. Each of these primary images gives unique information about an object.

A vibraimage shows a real physical and psychophysiological phenomenon. Depending on the purpose of its application it is possible to offer various definitions of the term.

A vibraimage is an image that shows the spatial and temporal parameters of the movement and vibration of an object.

A vibraimage is an integrated display of psychophysiological parameters of a person.

A vibraimage of a person is an information and probabilistic display of thermodynamic processes of a person who is in a stationary state of mechanical equilibrium.

A vibraimage is the average rate of a video image change in its each point, calculated for a certain period of time.

5. IDEAL VIBRAIMAGE

An ideal vibraimage can be obtained if we know the trajectory in space of each point of an object. Then it is possible to determine the amplitude and frequency of displacement for each point of a body in three-dimensional space. In reality to obtain such an ideal vibraimage is impossible for a number of objective reasons.

To obtain accurate coordinates of spatial and vector displacement of each point it is necessary to have at least a stereo-information on displacement obtained from two television cameras. Merging and processing of such information in the conditions of real time and modern equipment is not feasible.

To obtain the optical information on the displacement of each point it is necessary to have a good optical contrast between the points of an object. A human face is an object, about 80 per cent of whose points are slightly different from the neighboring points in contrast, i.e. it has a high coefficient of spatial correlation, therefore, to determine the exact displacement for each point by optical methods is practically impossible.

The speed of standard modern computers is not enough to keep track of a vector displacement of each point of an object even under conditions of flat image obtained from one television camera in real-time.

Real systems are noisy, and the noise level affects the resulting vibraimage. For low-contrast objects or areas of an object, the noise level exceeds the optical contrast of the neighboring points of an object which makes it impossible

for the optical detection of their displacement. Therefore, there have been developed the methods of obtaining a real vibraimage, which differs significantly from an ideal one, but allows showing informatively the movements of a person. The obtained real image is interesting not because it exists, but as much as it informatively shows the motor activity of an object under study. For informative display of the micro-movements of a person's head there has been developed the principles for obtaining a real image, which is significantly different from an ideal one, but accurately shows the dynamics of a person's movement.

6. REAL VIBRAIMAGE

What is a real vibraimage and how it differs from an ideal one? The main difference of a real vibraimage is connected with the proposed principle of its obtaining which is accumulating and analyzing frame-to-frame difference. In this approach, a standard image (frame) is not analyzed at all, and all the processing is carried out only with the inter-frame difference. This results in a dramatic decrease in the amount of the information to be processed, and there is an opportunity to carry out a real time processing while real displacement of the points of a body in space is not measured.

In a real vibraimage the amplitude of change of a signal of a photosensitive element of the matrix in the television camera replaces the amplitude (distance) of the displacement of each point of an object, which is not always the same.

With the accumulation of inter-frame difference there is the accumulation of information on an object's displacement in each element of the matrix, which is approximately focused at a certain point in space, i.e. we are watching the space, not the object. In this case the frequency of change of a signal of the points in space correlates with the frequency of a body's movement under certain conditions providing the adequacy of a real vibraimage to an ideal one. One part of these conditions or factors concerns the object under study, and the other concerns the equipment and settings of the software applied for obtaining the qualitative vibraimage. The joint implementation of all the following quality factors is desirable although in actual practice we often have to sacrifice one factor for the benefit of another.

Optical Contrast

To obtain an informative real vibraimage, the object under study should have a certain optical contrast. A displacement of an object with minimal optical contrast like, for example, a white sheet of paper or an evenly painted wall, doesn't result in a real vibraimage. If an object has points with high optical contrast, it is only their movement that will be noticeable in a real vibraimage. Since the optical contrast of the image of an object depends on the spectral composition of the incident light, it can be improved, for example, when an object is illuminated with a more shortwave (blue) light. As an example of a contrast optical object, we use the standard television test chart (fig. 6 and 7).

Fig. 6. *Usual image of a television test chart*

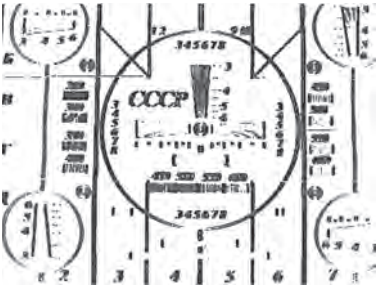


Fig. 7. *Vibraimage of the test chart making small vibrations*

Object's Movements

To obtain a high-quality and informative vibraimage, the object under study should make independent periodic movements relating to fixed space points. When obtaining a vibraimage of moving objects (making macro-movements) the settings of time of vibraimage accumulation are usually established much less, than when observing objects in a stationary equilibrium state (making micro-movements).

Here and further, by a stationary state of the object, we understand a relatively fixed in space location of an object, for example, a person standing or sitting in one place, being in a quasi-equilibrium state, and making small (micro) displacements and movements in space.

The independence of an object's displacement is understood as the absence of mechanical contact between the object under study and another object. For example, the vibraimage of a freely standing person significantly differs from the vibraimage of a person leaning against a wall. This is because some of the energy of a person's movement is transferred to the wall, the algorithm of work of the vestibular apparatus changes, and the obtained vibraimage does not show what part of the energy has been transferred. It depends on the contact area, the form and type of efforts and other factors.

The provided figures 10 and 11 confirm the deterioration of the vibraimage for the dependent object (leaning against a wall), because the more saturated a vibraimage is, i.e. the more points of an object is registered, the more information on the movement of an object's points is obtained and the closer the obtained real image is to the ideal vibraimage.

Illumination of the Object Under Study

The object should be illuminated evenly (in space) and steadily (in time) (fig. 12). Uneven illumination of an object in space makes it impossible to detect the movement in overly bright and dark areas, as there is no optical contrast between the points of an object (fig. 13), and this leads to reduction of informational content of a vibraimage. Any change of illumination of an object in time is perceived by the real VibraImage system as vibrations of an object (fig. 14) because the value of the signal at each point in the obtained image

Fig. 8. *The vibraimage displaying the accumulated amplitude of vibrations in each point*

Fig. 9. *The vibraimage displaying the accumulated frequency of vibrations in each point of a pseudo-color scale*

Fig. 10. *The vibraimage of a person in the state of independent equilibrium*

Fig. 11. *The vibraimage of a person leaning against a wall*

Fig. 12. *The vibraimage at a uniform spatial illumination of an object*

Fig. 13. *The vibraimage at uneven spatial illumination of an object*

Fig. 14. *The vibraimage at uneven temporal illumination of an object*

changes, and there appears a false vibraimage. Anyone who took pictures knows how a good illumination of an object is important for obtaining a quality photo. A good illumination of an object is the main requirement for obtaining a high-quality vibraimage. Uneven and unsteady illumination of an object makes a vibraimage uninformative and the rest of the analysis of the results useless.

Camera Fixation

Television camera observing the object should be rigidly mechanically fixed. The real VibraImage system cannot distinguish the movement of an object from the movement of a camera. This requirement significantly limits the possibility to use a VibraImage system in transport where camera vibrations can't be avoided. Moreover, the further away the object is from the camera, the less should be the vibration of the camera to ensure the required level of noise.

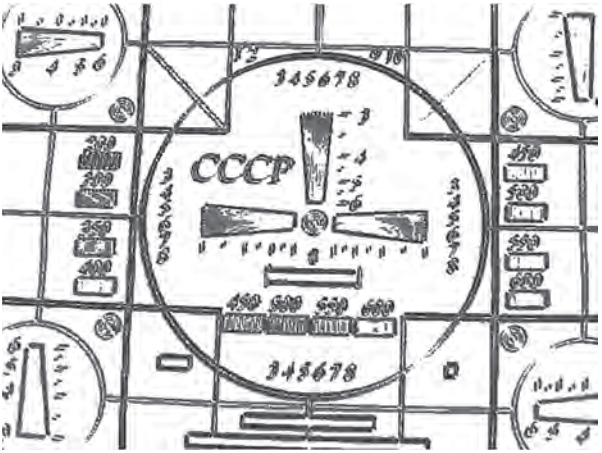


Fig. 15. *The vibraimage of the test chart when the camera is moving.*

Naturally, if the camera and the test chart remain motionless there is no vibraimage of a motionless object. The similarity of images in figures 7 and 15 confirms the equivalence of vibraimages obtained when an object and a camera move. Therefore, to detect the movements of an object the camera should not make vibrations.

Resolution of TV camera

Resolution capability of a system is the most important parameter for any photo-electronic system. It is determined by the optics and the image sensor of a television camera. We shall consider this parameter in detail since practically all other functional parameters of a system depend on it.

The resolution parameter of a TV camera is similar to the resolution parameter of a vibraimage and television image. However, they are not formally identical, though at computer processing there is virtually no difference between them. Some technical differences between the processing of a video signal from a camera and the processing of a signal recorded to a file concern high-speed performance, as reading the recorded file from the hard disk requires less computer resources than the signal input via the USB interface, and the processing of the recorded uncompressed avi file takes about 30% less CPU power than the of processing a live video. In this case the primary desire to have the maximum resolution of the system is illogical due to the issues related to system performance. The minimum resolution value is determined by the threshold amplitude of the natural vibration of the human body, which, according to E. Mira y López, is 100 microns [5], and it roughly coincides with the value obtained by the author. When a person’s face is maximum full fit into a frame, because of television proportions of a frame 3 (V) : 4 (H) and

vertical location of a person's face, the object is no more than 50 % of the elements horizontally, which can be called effective. The standard size of a person's face horizontally is 200–300 mm, therefore, the resolution in the frame on an object is $R = L / K$, where K is the number of effective matrix elements of a television camera. Thus, the horizontal resolution of a matrix of 640 elements allows to distinguish in one frame the objects no more than 1 mm or 1000 microns in size, which is clearly below the required limit of 100 microns. However, increasing the number of processed frames to 50–100 allows increase the accuracy of an object's definition, and this increase in accuracy can be in direct ratio to the number of processed frames or in proportion to the square root of this number, depending on the nature of the movement of an object [20]. Thus, even in the worst case, the increase in the number of the processed frames up to 100 allows to record an object's coordinates with an accuracy of 100 microns. It is identical to the measurement of the accuracy of an object's movement during the time of accumulation of the specified 100 frames.

Therefore, the reduction of resolution below 500–600 elements horizontally is fundamentally unacceptable and cannot be compensated by other parameters of processing of a vibraimage (see fig. 16 and 17). The double increase of resolution 1200 × 960 horizontally, theoretically, can result in approximately twice increase in accuracy of vibration measurement, while maintaining the noise and the speed of video signal processing. The conducted research has shown that to achieve this is not yet possible with the current state of technology. The double increase in linear resolution of the matrix results in four times reduction of the area of a photosensitive element, which increases the noise level by 16 times, while maintaining the area of the photodetector.

Fig. 16. *The vibraimage of a person with a 640×480 resolution.*

Fig. 17. *The vibraimage of a person with a 320×240 resolution.*

Fig. 18. *The vibraimage obtained at frequency f=10 frames/s*

Fig. 19. *The vibraimage obtained at frequency f=5 frames/s*

Fig. 20. *The vibraimage obtained at frequency f=2 frames/s*

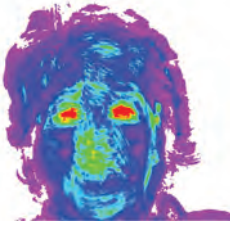


Fig. 21. *The image of a person when the system is set up default (N=100)*

Fig. 22. *The image of a person when default setting is changed (N=10)*

Fig. 23. *The image of a person when default setting is changed (N=2)*

The speed of the required processing of a video signal of a format 640×480 takes up 60–80% of the power of modern processors, and the double increase in line resolution will increase the processing time by 4 times, therefore, the processor will not be able to work in real-time. Thus, despite theoretical preference to the mode with big resolving power, the transition to line resolution of more than 1000 items is unreal at the moment, and the size of standard frames 760 x 580 (CCIR), 640×460 (avi, MPEG2 uncompressed) is considered to be optimal.

From figures 16 and 17 it follows that a vibraimage with a lower resolving power is characterized by quality deterioration, appearance of fragments and loss of information on the movement of many elements.

The Rate of Frames Input

As for the resolving power parameter, the choice of input rate or time between adjacent frames to be processed is determined by both technical and physiological restrictions. A preliminary study on the frequency of similar processes involves the thesis that the higher the rate of frames input is, the better. However, this thesis is directly in conflict with the power of modern processors, but if it is functionally necessary, then processing power, of course, can be increased.

A vibraimage is a functional analog of electroencephalography, and it is known that the frequency of EEG signals is limited to the range (0–30) Hz [21]. At the same time, the conducted study of vibraimage parameters by means of high-speed cameras with frames rate up to 1000 Hz showed no significant differences in the vibraimage of a person obtained when the input speed is higher (12–15) Hz, and a standard vibraimage. This is due to the laws of mechanical inertia that

filter high-frequency processes. Mechanical movement of parts of a human body, primarily the head, does not contain the frequencies exceeding 10 Hz [http://en.wikipedia.org/wiki/Vestibular_system], and to register such frequencies it is quite enough to have the frames input frequency of (12–15) Hz (according to the Whittaker–Nyquist–Kotelnikov–Shannon sampling theorem), if there is no need for exact restoration of a signal waveform [20, 22, 23]. The quantitative relationship between the stimulus and the sense organ is quite complex. The laws of Fechner and Stevens [9] suggest logarithmic and exponential relationship respectively. Simplistically it is assumed that a conscious response of a person to a stimulus usually exceeds 0,1 second [24], which also corresponds to the frequency of 10 Hz. This psychophysiological phenomenon allows the use of standard web cameras for high-quality registration of a person's vibraimage, which significantly increases the applicability of the system and method. However, it does not mean that any webcam with 640×480 resolution and 25–30 frames input frequency per second allows obtaining a high quality image of a person. For this purpose it is necessary that the camera should have a sufficient dynamic range and minimum noise level.

Determining the optimal frequency of frames input when sampling a movement is one of the main issues requiring further research to enhance the information content of vibraimage. The significance of this time discrete is similar to the definition of the bit in computer science, on which all modern digital and computer facilities are based. The correct definition of this time interval can significantly increase the signal/noise relation when detecting the required psychophysiological characteristics, with minimal hardware and software expenses. Currently, it is assumed that the increase in informational content is achieved at frames input

frequency of $f = (5–15)$ Hz, and to detect different psycho-physiological parameters different frequencies are used. The stochastic nature and noise level of a real vibraimage does not allow obtaining unambiguously a less high-frequency vibraimage from a more high-frequency one. Every vibraimage is informative in its own way, and the input frequency should be determined with consideration of many factors.

The provided figures 18–20 confirm that the increase in the frequency of a vibraimage processing (reducing the time between the frames of the interframe difference) leads to the change of informational content of a person's vibraimage.

Dynamic Range and Noise Level

All elements of the system should provide a minimum level of temporal noise when obtaining the image. To check the quality of the system in this parameter is easy: the camera should be focused on a motionless contrast object. The quality system will show almost zero level of a vibraimage, and a noisy system will reveal contrasting details of an object (fig. 24).

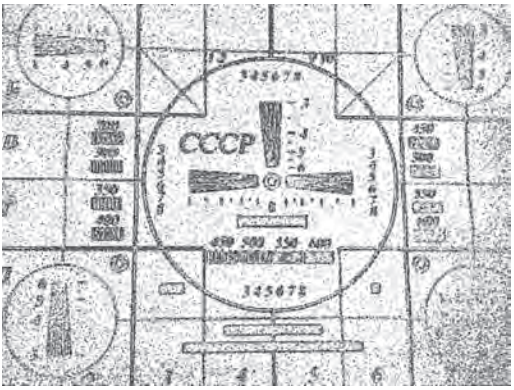


Fig. 24. *The vibraimage of a motionless test chart, obtained by the TV camera with a high noise level*

It is natural that a certain value of noise level is present at any camera therefore the comparison of cameras should be carried out by a uniform technique for obtaining objective comparative results.

Unfortunately, the producers of the television cameras rarely give technical details about the dynamic range of television cameras, and when they do it, each manufacturer carries out testing based on their own techniques, and the comparative analysis of these data is complicated. Therefore, the studies of noise level and dynamic range of more than 50 TV cameras from various manufacturers and of various structural implementations have been conducted. The analysis showed that in this parameter the majority of the studied cameras are of poor quality, high noise level and a small dynamic range. Cheap web cameras have a higher quality and low noise level, and more expensive camcorders, especially those with digital microprocessor processing, have a higher noise level. Also, trendy at the present time, the increase in the number of matrix elements promotes the increase in video signal frequency and the reduction of a photosensitive area of an element; both of these factors lead to the increase of noise level. Standardly (GOST 28951-91) the dynamic range is defined as the logarithm of the ratio of maximum signal to a root-mean-square deviation of noise, with virtually all the studied cameras being eight-bit, and in this case, the maximum signal level is 256 bits. At identical maximum signal, it is more informative to carry out the assessment of a camera quality on the noise level as this characteristic reflects the quality linearly, but not logarithmically. According to the methodology, the noise level testing is carried out on the contrast test chart, as the noise level of a vibraimage depends on contrast of an object; a low-contrast object has considerably smaller noise of a vibraimage than a contrast object. Also it is necessary to consider that to

register a movement the black-and-white component of a signal is analyzed, and the cameras with hardware built-in function of switching in a black-and-white operating mode have the best performance on noise level. The lack of such function leads to reduction of the informative area of a photosensitive element by 3 times and to increase in noise level by 9 times.

Parameter	Measure-ment Units	Video source				
		001	002	003	004	005
Resolving power	TVL	450	600	440	450	450
Average noise level of vibraimage	bit	0,001	0,08	0,05	0,09	0,001
Input frequency of digital frames	FPS	12,5	15,0	14,2	15,0	15,0
Frequency range	Hz	0–11	0–10	0–10	0–10	0–11

As a video signal source used in the products:

001 — digital web camera Genius Video Cam Web V1 (interface USB 1.0);

002 — digital camcorder Samsung VP-M2100S recording avi files;

003 — digital web camera Genius Video Cam Messenger (interface USB 2.0);

004 — digital camcorder Sony DCR-HC15E with IEEE1394 interface;

005 — analog video camera YOKO YK-577F with a digitizing unit EZMaker from AVerMedia.

From the digital cameras currently available in the market (the year 2007), only Genius Eye 311Q is comparable on noise level with the best samples of the studied cameras and can be used for obtaining the informative vibraimage.

Optimal Distance from Camera to Object

When determining the optimal distance from camera to object, to fit an object in the monitor screen it is necessary to analyze and select the following factors:

a) operating angle of the lens;
b) illumination of an object;
c) mechanical stability of camera;
d) stability of air between the camera and an object.

Lens parameters and object illumination can influence the noise level, and the increase of noise level of a vibraimage leads to the increased likelihood of errors in identifying the state of an object. To compensate for the loss of illumination, when increasing the distance from the camera to the object it is necessary to increase the illumination of the object in proportion to the square distance to the object. To compensate for mechanical instability, it is necessary to take measures to reduce the vibrations of the camera. The rigidity of the mechanical camera stabilization should be proportional to the distance from the camera to the object. The distance of no more than 10 meters to the object requires no special measures for mechanical stabilization of the camera, and to work at greater distances the rigid mechanical stabilization of the camera is obligatory.

System Settings

The system setup should correspond to the task being solved. This provision is formulated rather broadly and provides an understanding of the nature of the registered process and the system capabilities. We shall repeat that the minimum time of a person’s reaction to the impact makes 0,1s. This means

that the interval of the movement sampling of 0,05 s is sufficient for obtaining the adequate vibraimage of a person, and the total time of accumulation in 20 s includes the time period of the basic physiological processes in a human body which are connected with that emotional state. It should be understood that depending on the selected settings and modes, we can obtain completely different pictures of a person's vibraimage characterizing his state dependently or independently.

The settings of VibraImage system, installed by default, are designed to obtain a person's vibraimage, and to determine his emotional state.

Currently the following main system settings by default are offered (fig. 21), which, in the author's opinion, most fully reflect the motor activity of a person:

$N = 100$ — the number of frames of vibraimage accumulation;

$FPS_{in} = 15$ — input frame rate;

$FPS_{out} = 5$ — frame processing rate.

The proposed settings allow, if necessary, determining fast-changing parameters of a person and capturing low frequency changes. The reduction of time of vibraimage accumulation up to 10 frames (fig. 22) or to 2 frames (fig. 23) significantly changes the registered picture and can be applied by an experienced user of the system to filter certain psychophysiological processes.

7. VIBRAIMAGE ANALYSIS

To carry out the analysis of the resulting vibraimage it is necessary to accept several axioms which have formed the basis of the theory and the method of obtaining a vibraimage.

The acceptance of certain postulates or axioms is the basis of any science, and primary validity of these provisions largely determines the further development of the theory. The axioms accepted on the basis of technical and psycho-physiological knowledge have allowed to develop rather simple technical system allowing to scan and identify remotely and contactless a psycho-physiological state of a person.

Informativeness of Quasi-equilibrium State of a Person

Mechanical quasi-equilibrium state of a person informatively reflects his emotional state.

The physical and theoretical meaning of this assumption is explained in the Chapter on the energy model of emotions. However, as usual, first it has been established experimentally, as a vibraimage of a person making meaningful movements (walking, gestures) practically were unprocessable informatively. At the same time, there is an obvious psychophysiological informativeness of vibraimages for extreme variants of psychophysiological states (such as quietness and rage) for the objects that are in mechanically quasi-equilibrium state.

By mechanically quasi-equilibrium state of a person we understand a free condition of mechanical balance (standing,

sitting) in which the movements are determined by unconscious processes, primarily by the work of the vestibular system.

Informativeness of Maximum Frequency

*The registered **maximum** frequency of point vibrations of quasi-stationary movements of the head informatively characterize a psycho-physiological state of a person.*

This thesis, though it may seem simple, allows making a number of important assumptions. But first, there are some explanations of the essence of this postulate. It allows discarding the registered low-frequency vibrations, primarily because they are determined not so much by the real movement of the points of a body, but by the feature of a method of registration of a vibraimage and the physiology of a human body.

The maximum frequency of a vibraimage fragment is most informative. If one point moves under control of the muscles of a body or face, the adjacent points also make similar movements, but with lower frequency and amplitude.

Naturally, the movement of the neighboring points is determined not by a psychophysiological cause or by “thought” according to Ivan Sechenov [2], but by the anatomical features of a human body, skin stiffness and relative amorphousness of a human body. Visually, it is rather difficult to allocate single dots on a color or monochrome image, however, the maximum frequency is easily calculated in software from any fragment.

The lack of optical contrast or slight optical contrast can significantly distort a vibraimage parameters recorded at each point. However, the maximum frequency of vibrations on a rather extended part of a body is of low sensitivity to the magnitude of the optical contrast, as the probability of occurrence of at least one contrasting point on the object increases with the increase of the area being analyzed. Historically, television systems

have mainly line scanning principle. This principle is used also to analyze a vibraimage, which is analyzed line by line, finding the maximum frequency of vibration for each line.

It should be understood that the purpose of obtaining a vibraimage is the most accurate determination of the parameters of the movement of the head of a person in equilibrium state, as they represent a psycho-physiological state of a person. The elementwise spatial analysis is necessary for a more precise determination of the integral parameters of the movement, therefore the transition from element-by- element to line-by-line analysis is a logical step in this direction.

Spatial Informativeness

Spatial irregularity of a vibraimage informatively characterizes a psychophysiological state of an object.

A primary vibraimage represents a matrix of instant values of amplitude and/or frequency of vibrations of points of a body.

Spatial irregularity of this matrix can be determined by irregular (asymmetric) movement of the points of a body or by the optical unevenness of an object. At frontal observation, a human face can be considered relatively symmetric; therefore, the observed asymmetry of the vibration indicates the irregularity of the movement of an object.

Encephalic asymmetry determines personality characteristics and affects behavior [25]. Electroencephalographic studies show significant differences in the symmetry of electric activity of a brain for a person in an active state; therefore, separate measurement of left and right side of a vibraimage should significantly improve the information content of the analysis.

Spatial asymmetry in the control of vestibular system movement in maintaining balance depends on a variety of brake actions when passing control signals or muscular contraction.

The specified distinction in the inhibition is not a random value; it is a function of psycho-physiological state of a person.

The asymmetry of the spatial and temporal components of the vibration is largely due to the physiological asymmetry of a human body and, above all, functional asymmetry of brain activity. Practically it is implemented as follows: the left and right sides of the resulting vibraimage are analyzed simultaneously and independently, i.e., for example, independent values of frequency and amplitude are determined on the left and right part of each line of a vibraimage.

Space-temporal Informativeness

The change of the spatial characteristics of a vibraimage in time informatively characterizes the state of an object.

The registration of changes in psycho-physiological parameters in time is used for the analysis of the known physiological processes, such as EEG, ECG, GSR, etc. For all listed physiological processes the measurement of physiological parameters is carried out at a certain point of a body (space). The matrix principle of obtaining a vibraimage allows to summarize invariantly the values of frequency and amplitude of a vibraimage on an arbitrary fragment and/or around the entire frame, and to carry out various intra-frame processing to obtain informative characteristics of an object.

The simplest but quite informative characteristics of a vibraimage is a space-temporal histogram of frequency distribution obtained for all matrix elements and several frames. The frequency histogram allows to combine the opportunities of processing point psycho-physiological characteristics of EEG, ECG, GSR and spatial imaging of ultrasonography, MRI by means of Shannon Information theory [23], since the obtained real vibraimage is an information and probabilistic characteristics.

Random values of frequency or amplitude at each specific point can be determined by many processes, but statistical characteristics, such as mathematical expectation and dispersion, accurately detect information and probabilistic initial process.

The main principles of a vibraimage analysis given above, allow to define and identify quantitatively a psycho-physiological state of a person on the basis of the data on micro-movements and/or micro-vibrations of his head.

8. VIBRAIMAGE PARAMETERS

The actual vibraimage of an object shows the parameters of the movement of an object's points and depends on the optical contrast between its points. Only if each point of an object differs by contrast from the adjacent ones, a vibraimage will be present at each point of an object. The display of the accumulated amplitude of displacement at each point by means of a pseudo-color scale creates an image which is bearing a faint resemblance to the actual color image of an object, or a thermal image, where color represents temperature. The amplitude component of each point of a vibraimage is determined by the formula:

$$A_{x,y} = \frac{1}{N}\sum_{i=1}^{N}\left|U_{x,y,i} - U_{x,y,(i+1)}\right|,$$

where x, y — coordinates of a point;

$U_{x,y,i}$ — the magnitude of the signal at point x, y in the i-th frame;

$U_{x,y\,(i+1)}$ — the magnitude of the signal at point x, y in (i+1) frame;

N — the number of frames on which there is an accumulation of the amplitude component of a vibraimage.

The display of movement frequency at each point of an object (actually a space) creates an image similar to an amplitude one, but slightly different from an amplitude one when displaying by means of a pseudo-color scale, since the change of a signal at a point is recorded regardless of amplitude, only 0 or 1.

The relative frequency component of each point of a vibraimage is determined by the formula:

$$F_{x,y} = \frac{F_m}{N} \sum_{i=1}^{N} \begin{Bmatrix} \Delta_i <> 0:1 \\ other:0 \end{Bmatrix},$$

where Δ — interframe difference for the i-th point of an image;
N — the number of frames on which there is an accumulation of the amplitude component of a vibraimage.

To convert relative frequency to actual physical frequency with dimension (Hz) it is necessary to bring the obtained value into compliance with the number of frames processed per second.

Naturally, it is impossible to display simultaneously two numbers at one point on a flat image, therefore at visual viewing the amplitude and the frequency images of an object are displayed to the monitor screen sequentially.

The given formulas confirm that the actual amplitude vibraimage represents the amplitude of a signal change at each point of space, and the actual frequency vibraimage represents the frequency of a signal change in a space point.

Further, to simplify terminology, we will call an actual vibraimage simply a vibraimage. When implementing the conditions described in Chapter 6, the difference between the parameters of an actual and an ideal vibraimage may be minimal, in this case it is possible to say that the vibraimage represents the amplitude and frequency of an object's movement.

The fact that a vibraimage depends on the parameters of a body's movement was clear from the very beginning because a vibraimage occurs only in living and moving objects. However, to understand the dependence of a vibraimage from psycho-physiological state of a person appeared not easy.

Curiously enough, another guess or historical analogy helped to realize the information content of a vibraimage. It is known that, in certain cases, the state of mind of a person is visualized and displayed in the form of aura. A vibraimage is intrinsic to living objects, and if a person or an animal dies then their vibraimage also dies away. Therefore, we decided to represent an external vibraimage of a person (showing the amplitude and the frequency components of the internal vibraimage) in the form of an aura (fig. 38), and in the beginning, in the form of a classical aura, located radially around a person's head. However, radial arrangement of an aura requires more computer resources than a line binding, while informational content does not increase. In addition, a line binding of an aura — an external vibraimage makes it visually distinct from religious and historical one, which is certainly correct, as for creation of the given aura scientific and technical principles of characteristic of a person's state are used.

In the process of working on the technology, an external vibraimage or aura held its own path of development in accordance with our understanding of the meaning of technology for the ultimate display of movement energy and psychophysiological parameters of a person. At the moment, the color of an aura represents the maximum frequency of a vibraimage line, and the size of an aura represents average amplitude of vibration in a line.

Later we will return to physical sense of aura, and for now we pass to vibraimage parameters which choice goes through a visual analysis of the resulting aura.

Primary Parameters

The most complete and simple characterization of any object is possible with the help of the parameters with minimal

functional correlation between them. If two parameters are interdependent, then there is no sense to use them together to characterize an object, one of them suffices. Therefore, to characterize a vibraimage there have been selected four functionally independent groups of the parameters describing various properties — amplitude, frequency, symmetry and processing of a vibraimage.

The parameters in each group are also conditionally divided, according to the time of determination or operating speed, into the parameters of maximal operating speed (the accumulation time is about 0,1 second), medium speed (the accumulation time of about 1 second), maximum accumulation (the accumulation time of 10–20 seconds), similar to the “temporal triads” of Nikolay Bogolyubov [13]. These temporal groups are defined by various psychophysiological processes in a human body. As the minimum time of a person’s reaction to any impact makes 0,1 second, the parameters of maximal operating speed are responsible for the registration of rapidly changing characteristics of a person.

Respectively, the parameters of the second group record a person’s state which changes with a frequency about 1 Hz, and the third group parameters record slowly changing states. If a person is in a quiet and stationary state, then most informatively he can be characterized by the third group parameters. To detect lies and to characterize non-stationary states, the parameters of the first and second groups are most informative.

The type of a person’s vibraimage considerably differs at different time of parameters accumulation, even if a person is in a stationary state (see fig. 21, 22, 23).

9. ENERGY MODEL OF EMOTIONS

"I will explode now as three hundred tons of trotyl."
Vladimir Vysotsky

The assumption that the micro-movements of a person in equilibrium represent his psycho-physiological state, was confirmed with comparative tests and the parameters measurement by means of the well-known methods (EEG, GSR, ECG) and psychological testing (Buss-Durkee, Hand-test, Lüscher test) [26]. Once the result obtained, it seems obvious enough, especially as the connection of a person's psycho-physiological state and his movement parameters follows from the works of Darwin, Sechenov, Freud, Mira y López, Lorenz, and the laws of thermodynamics.

The first law of thermodynamics [19] defines energy transformation. The change of internal energy of a closed thermodynamic system is equal to the sum of the amount of heat transferred to the system, and the work performed by the system. Mathematically, the first law can be formulated as

$$dU = \delta Q - \delta W,$$

where dU represents the change of internal energy of the system, δQ represents the amount of heat received by the system and δW represents the number of the work performed by the system relative to the environment. According to Gladyshev hierarchical thermodynamics [13] it can be argued that a person in a state of mechanical equilibrium, at the same time is in a state of biochemical quasi-equilibrium, and δW represents the amount of work performed by the system in the form of micro-vibrations. The system of thermal regulation of a person maintains stable temperature of a human body;

therefore, it is possible to consider that emotional energy must be proportional to the movements and micro-vibrations of the head.

The man is an extremely complex biological system, but the energy conservation law is obligatory for any closed system. If emotional states of a person differ among themselves, then they should differ with the change in internal energy and the work performed by a person. There are only a few mechanisms of energy release, these are the release of heat, emission, and mechanical work, i.e. motion. It is rather difficult to record non-thermal radiation of a human. It has a weak power, and will be considered in the next Chapter. It is well known that thermal processes are connected with emotions [27], GSR reflects the thermoregulation process and successfully used in lie detection [6] and detection of emotional state.

The conversion of emotional state energy into mechanical motion (work) is as much significant, natural and obligatory process of energy regulation as thermoregulation, however, so far, for some reason, the connection between movement and emotions was not considered as a natural consequence of the law of conservation of energy. A person, who is in a state of emotional excitement and has to be in a fixed position, does not differ from a cocker on hunting. He also has to make mechanical micro-movements to compensate the release of internal energy. Of course, the frequency and amplitude of these movements depend also on the extent of a person's control over his state, and if a person tries to hide his state, then we deal with hidden emotions. At the same time, to completely exclude micro-movements is as impossible as to lower body temperature to absolute zero on the Kelvin scale. It is natural that the intensity and nature of micro-movements depend on the amount of the released energy, and in its turn, the released energy depends on the experienced emotional state.

The physical view of the vibraimage which is reflective of the thermodynamic model of emotions [13, 14], suggests that any emotion represents the function of change of the amount of work performed by a person in time and space and, in a general way, can be expressed by the formula:

$$E_i = f_i\left(\frac{\delta W}{dt};\frac{\delta W}{d(x,y,z)}\right),$$

where E_i — the i-th emotion (aggression, stress, anxiety, etc.);

$\frac{\delta W}{dt}$ — temporal change in the amount of work performed by the head of a person, in the form of micro-movements and micro-vibrations;

$\frac{\delta W}{d(x,y,z)}$ — spatial distribution of the amount of work performed by the head of a person, in the form of micro-movements and micro-vibrations.

The offered functional dependence of emotions definition is of a general character and can be specified further. At the same time, the formulas to determine specific emotional states on spatial and temporal distribution of vibrations of a human head are of a greater interest. To exemplify and discuss, the formula for determining the level of aggressiveness of a person is given further.

The hierarchical thermodynamics [13] considers the objects which are in an equilibrium state, and the mechanical equilibrium for a complex system automatically assumes equilibrium at all other hierarchical levels — energy, biochemical, etc.

Vibraimaging for psychology is similar to the invention of the microscope for biology, at the level of micro-movements a new world of emotions, which can be detected automatically by technical means, is being revealed. Vibraimaging is nano-

psychology, where a few nanometers shift of the gravity center of a person in equilibrium reflects the manifestation of consciousness and subconsciousness.

Frequent use of analogies is natural in the early stage of the research since to determine the correlation between emotions and vibraimage it is required to carry out extensive and versatile experiments. The use of logic and analogies to determine this correlation can be the only way to reduce significantly the amount of research. Theoretical modeling followed by experimental confirmation is preferable.

The examples of distribution of internal energy and the calculation of vibraimage parameters for the state of aggression and anxiety are considered further. Probably, other calculation algorithms of these emotional states also can be offered, although the proposed options have shown good agreement with the experimental data. The author hopes that the proposed energy model to determine an emotional state based on the calculation of micro-movements (psychomotor system) will become standard in the near future.

Calculation of Aggression Level

Consider the calculation of emotions by the example of the state of aggression. Modern psychology distinguishes over 200 various emotional states (http://en.wikipedia.org/wiki/Emotion), and for each specific emotion there can be a huge number of definitions. For the state of aggression there are more than a hundred definitions [26, 28], and some sources refer aggression to emotions, and others do not. Practically everyone believes that in the state of aggression a person is quite active and excited. Hence it is logical to assume that in an aggressive state the frequency of all physiological processes in a human body increases, so does the frequency of a vibraimage.

It has been experimentally confirmed that at the increase of aggressiveness, the average frequency of a vibraimage increases. However, some psychological states, for example, the state of active concentration, are also characterized by the increase in average frequency of a vibraimage, though it obviously differs from the state of aggression. At the same time it was noted that the state of active concentration (fig. 25) is characterized by minimal dispersion of vibraimage frequency, while in the state of aggression there is a significant dispersion in the distribution of frequency. The noticed regularity allows determining the level of aggression as the sum of an average value of frequency and RMSD of frequency distribution.

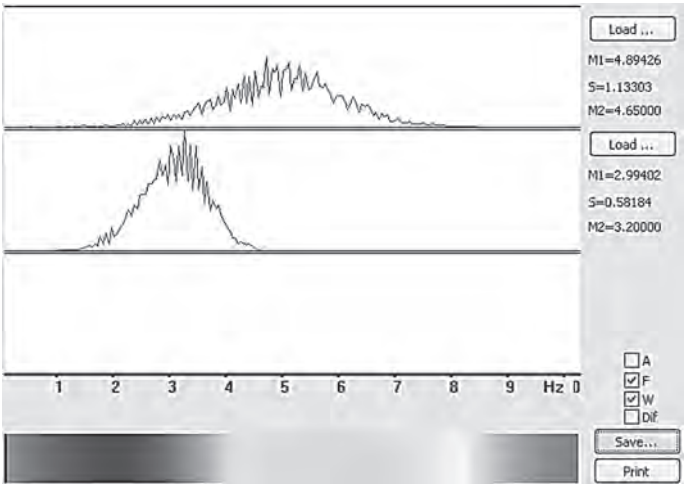


Fig. 25. *A standard histogram of frequency distribution for the state of active concentration*

It is proposed to characterize each distribution (the frequency histogram) by the following basic mathematical characteristics: M1 — mathematical expectation (arithmetic average of distribution), S — root-mean-square deviation

(RMSD characterizes the width of distribution), M2 — the value of frequency corresponding to the maximum of distribution. From the provided figures, it follows that the offered mathematical characteristics of frequency distribution considerably depend on a state of a person, however, it does not exclude a possibility of introduction of new informative mathematical characteristics to display the frequency distribution.

The obtained dependences have a logical psycho-physiological explanation. The state of intense attention focusing is associated with the increase of concentration and frequency synchronization of all basic psycho-physiological processes. At the same time attention focusing results in the decrease of frequency vibrations dispersion, i.e. all points and organs of a person work synchronously. For the state of aggression, on the contrary, asynchronous processes are characteristic as some psycho-physiological processes are accelerated and others are decelerated. Such verbal description of aggressiveness gave many great scientists of the past, for example, Darwin and Lorenz. Unfortunately, they had no potential of the modern computer facilities and video systems, otherwise vibraimaging and emotions calculation on the parameters of a vibraimage could have been carried out 100–200 years earlier. Proceeding from the above, the following formula for calculation of aggression level was offered:

$$Ag = \frac{F_m + 4 \times \sqrt{\frac{1}{n}\sum_{1}^{n}\left(F_i - \bar{F}\right)^2}}{2\mathrm{Fin}},$$

where Ag — aggression level;

F_m — the frequency of the maximum in the density histogram of frequency distribution;

F_i — counting number with the *i*-th frequency in the histogram of the density of frequency distribution obtained during *N* frames;
Fin — input processing vibraimage frequency ;
n — counting number with inter-frame difference above threshold in *N* frames.

The first component of the numerator of the formula for calculating the level of aggressiveness (F_m = M2) determines the shift of distribution along the axis of frequency, and a higher frequency of oscillation corresponds to an increase in the level of aggressiveness. The second component of the numerator is determined by RMSD (S in fig. 8 and 9) and characterizes the width of frequency distribution. A wider distribution corresponds to an increase in the level of aggressiveness of a person. When obtaining initial counting by means of the 8th bit camera, the coefficient of the denominator 512 allows to measure the aggressiveness coefficient in the relative units, changing from 0 (zero aggressiveness) to 1 (the maximal aggressiveness). To bring the rest of the calculated parameters of emotions to the range from 0 to 1 (or 0–100 %) is preferable thereafter.

This formula identifies the given level of aggression; the maximum value of aggression cannot exceed 100 %. The maximum value of the histogram of the spatial distribution of frequency, determined by the maximum time of accumulation (*N* = 50 frames), is located on the far right side, and the width of the root-mean-square deviation of frequency is equal to the entire frequency range (fig. 26). Mathematically it is rather difficult to represent the distribution corresponding to 100% of aggression; it can be roughly approximated by addition of the uniform and exponential distribution.

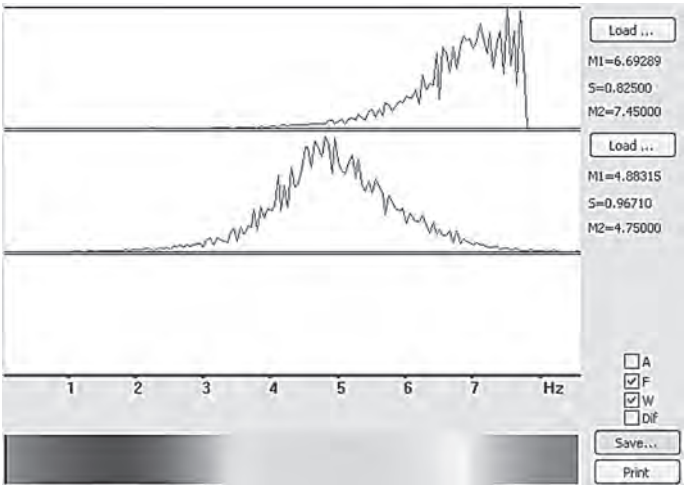


Fig. 26. *A standard histogram of frequency distribution for aggressive state*

Calculation of Anxiety Level

To display the level of anxiety, the temporal fast component ($N=2$) of vibraimage without regard to spatial distribution was used. In characterizing the general psycho-physiological state of a person by means of a limited number of parameters it is advisable to use parameters with minimum correlation as uncorrelated parameters characterize an object with maximal informativeness. It is known that anxiety increases the correlation of high-frequency brain activity in the alpha and beta bands [26]. The movements of the head are, of course, more inertial than electric activity of brain, but the ratio of a high frequency to a low-frequency motion component also appeared to be informative. The proposed calculation formula of anxiety is also brought to 100 %, and, in the case of increased anxiety, in the spectrum of a person's vibrations the high frequency component in the movement prevails over the low-frequency component.

When a person is in a calm state low-frequency vibrations prevail, and the range of vibrations corresponds to the exponential distribution law.

Anxiety calculation formula:

$$T = \frac{\sum_{\frac{f_{max}}{2}}^{f_{max}} P_i(f)}{\sum_{0,1}^{f_{max}} P_i(f)},$$

where $P_i(f)$ — spectral power of distribution of vibraimage frequency;

f_{max} — the maximum frequency in the spectrum of distribution of vibraimage frequency.

The graphs in figure 27 shows that the frequency spectrum of the vibration of a person in a calm state can be approximated by an exponent, while the frequency spectrum of the vibration of a person in an excited state is a more complex combination of several different distributions.

The graphs in figures 27 and 28 show that the frequency range of 5 fps can be insufficient for proper detection of a person's emotions in alarming or excited states as the top graph (fig. 28) breaks rather sharply, and inaccuracy in anxiety detection by the proposed formula will be high enough. The presence of a relatively high-frequency component (5–10) Hz at a vibraimage of active states of a person imposes various requirements to the analysis of high- and low-frequency processes, which should be combined in one hardware-software processing.

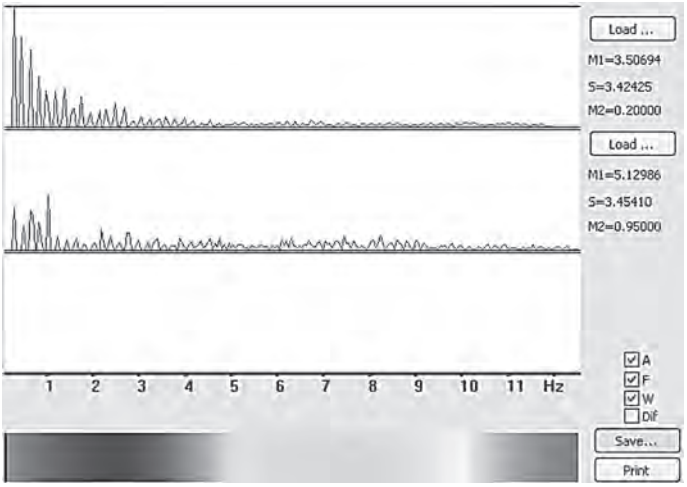


Fig. 27. *The frequency spectrum of the vibraimage integrated signal of an object in a calm state (top graph) and anxiety (bottom graph)*

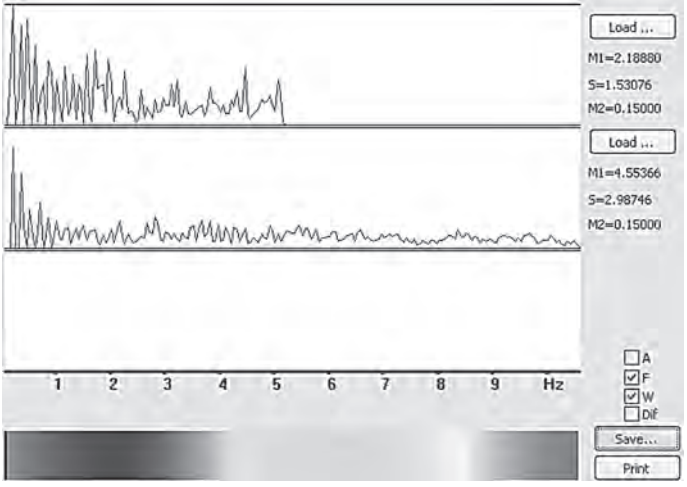


Fig. 28. *Comparative distribution of frequency spectra of the vibraimage of one state of a person, obtained with different frames rate 5 fps (top graph) and 10 fps (bottom graph)*

10. A BIOFIELD OR AN AURA?

Most scientists, who are engaged in studying of weak biological fields, prefer to use the term ‘biofield’ as the scientific analogue of the religious term ‘aura’. In my opinion, this is not quite correct since both of these terms have different meanings and can be used independently in scientific terminology. Let us try to divide powers between these terms, giving scientific definitions to each of them.

We shall start with aura. By the aura a set of a person properties or the integral psycho-physiological characteristic of an object should be meant. Not only a human or an animal but also a place, a book, a picture, etc. can have their own aura. The human aura is comprised of physical and spiritual components of a physiological state — mood, emotions, everything that determines and forms the state of a person at a particular point in time. The image of an aura (shape, color, and anatomical landmark) shows an integral state of a person.

The biofield is a physical characteristic inherent in any biological object which includes the known and/or unknown radiations of the thermal, light, gravity and electromagnetic waves formed by a biological object both at the cellular level and with the increase in extent of an object’s integration, for example, by certain body organs or systems and a person in general. With this characterization of the biofield, human thermal image is one of the biofield components. Unfortunately, other known components of human biofield have insufficient power for reliable direct registration by the modern technical means.

There is some technical difficulty to distinguish these terms, because any change in a person's state (aura) results in a natural change of the radiation (biofield). This is similar to the well known Ohm's law, when the change of current intensity in the conductor causes a single-valued change in the voltage drop. In electrical engineering no one confuses current intensity and voltage, they are measured by means of various, though related physical units. So it goes in biometrics, and the aura is the main integral characteristic of a person, and the biofield is one of physical characteristics by means of which a person can influence other objects. At the same time a person can influence other objects by means of words, touches, etc., that in most cases is more significant than influence by a biofield. Ancient images of human aura are found in all religions, and no religion depicts an aura separate from man. Such approach is preferable also from the scientific point of view, because an aura is not a luminous radiation surrounding a person but a person himself with what surrounds and characterizes him. The classical glow around a person displays the set of basic parameters characterizing the state of a person, which can also be combined into one basic property, for example, wisdom, holiness, etc., fixed by an artist as the color and shape of an aura. Therefore, the classical portrayal of the aura coincides with our definition and in fact contains nothing mystical.

Coming back to an external vibraimage, we shall define what it represents — an aura or a biofield. As it was proved that an external vibraimage is associated with psychophysiological characteristics of a person and has a clear anatomical reference, then an external vibraimage can be identified with an aura. If it is proved that there is some biological radiation proportional to the frequency of vibration of the points of human body, then the external vibraimage can be considered a biofield. At the moment biological radiation with the estimated

parameters is not detected, and it is premature to call an external vibraimage a biofield.

Automatic biometric systems distinguish one person from another by identifying biometric parameters. These include fingerprints, the size and shape of the face, hands, genetic code, etc. It is impossible to create the precise copy of a person, even uniovular twins or clones have different fingerprints. The majority of biometric parameters used to identify a person, slightly change throughout a person's life. However, the emotional state of a person may change significantly within one second, if he sees or hears important information. The combination of physical and spiritual parameters in one integral parameter, which we call an aura, is rather arbitrary, because, at first glance, it significantly simplifies the model under study. At the same time, however, there are new opportunities to analyze the parameters of human aura, and there can be much more opportunities besides those which are used to detect an aura.

Consider the possibility to build an aura on the basis of a vibraimage analysis. Previously I said that the first attempts of visual analysis of a vibraimage had not achieved a positive result. It is really difficult to identify the dot which slightly differs in color against the background of many other color dots. The transition to the image of the aura around the body significantly changes the situation. Thus, according to the foregoing axioms of vibraimage informativeness, the color of the aura is determined by the maximum frequency of vibration of the body points in each line of an image, separately for the left and right parts of the moving (vibrating) object, and the size of the aura is represented by an average value of the vibrations amplitude in these parts of the lines. Such a purely pragmatic approach to the visualization of significant parameters of vibrations, rather unexpectedly, produced very interesting

results. It turned out that such external vibraimage of a person is very similar to the classical aura in its various ancient representations, for example, on Christian icons. The aura visualized around the heads of most people appeared to be much more intensive, than that around the entire bodies. The coincidences did not end there. The scale of color coding of frequency and amplitude of vibration, identical to the curve of the conspicuity of a human eye, from purple color for low frequency vibration to red color for high frequencies of vibration, also selected for purely technical reasons, showed good coincidence to the identification of a psycho-physiological state of a person described in Buddhist religion [29].

It turned out that the shape and color of the aura, or the external vibraimage, informatively characterize physiological state of a person and his health, and its image in many respects coincides with historical and religious representations of the aura. Try to determine the reasons for this coincidence. It is unlikely that such coincidence can be accidental. It is most likely determined by the common mechanisms of logical reasoning and empirical data obtained in the course of human development which appear at the level of subconscious thinking.

What is the connection between aura and vibrations? If we assume the unity of building the energy of animate and inanimate nature, it becomes easier to answer this question. In the microcosm physics, wave and quantum properties of any electromagnetic radiation are always present together and separately. The photon energy ε depends on radiation frequencyv; $\varepsilon = hv$, where h is Planck's constant. If to transfer the principle of dependency of radiation energy of a living object on frequency to a living object, then it turns out that the radiation from a living object characterizes his energy, therefore, the intuitive image of an aura around a person has

logical scientific justification. I don't want to dwell on the fact, how realistic it is to see an aura, as it is claimed by many psychics. Suffice it to say that the human brain in its efficiency and quick operation in many respects surpasses modern computers, and if the computation of an aura and a vibraimage can be carried out by means of computer, then why similar computing process cannot be organized in the mind of a man? Moreover, that modern science still does not know how the process of thinking is really carried out, and we, in this book, are forced to stay within the limits of current knowledge. The human eye has a much larger (ten times) resolution power than the video camera, and it is the resolution power of a reading device that makes it possible to capture vibrations, therefore, people can see the aura on the basis of a vibraimage much better than any technical system.

Of course, many scientists can criticize this theory because the proposed image of an aura is virtual or conditional. However, in my opinion, it is no more virtual than a customary image. If an image shows actual properties of an object, then its virtuality or convention becomes absolutely unimportant. The main thing is the common use of the proposed conditional approach. But all this remains valid only if actual properties of an object are shown, otherwise sooner or later the conventional approach changes and society adopts a different solution. The aura in this sense has stood the test of time, and the term existing no less than six thousand years, is unlikely to be incorrect and unlikely to be changed in the near future.

Therefore, in the following chapters we shall consider various applications of vibraimage technology using the term aura, according to the given definition.

11. APPLICATION OF VIBRAIMAGE

Now that most of the book has already been passed, we can reflect on the theme of — who and why needs this vibraimage? The simple answer is for fun, it is just interesting to look at yourself and others from a different perspective, the way no one has ever seen before. One may recall the great physicist Faraday, who responded to the question of the Queen of England about the benefit from his discovery of electromagnetism, “Can You, Your Majesty, predict the fate of the newly born child?” The vibraimage represents the same primary type of the image as the x-ray, thermal, ultrasonic, magnetic and resonance or conventional color image. There are not so many primary types of images, and each of them finds application in many areas. All primary types of images have been once discovered and gradually developed; even our sense of vision is a long process of evolution. Perhaps, those applications which we suggest will not be implemented, but it is also possible that the vibraimage will find application where it is not possible to assume now. The vibraimage is the only type of images which is inherent in biological objects only when they are alive, after death the vibraimage disappears. This property allows to assume that the vibraimage shows some characteristics of an alive object related to its state, i.e. psychophysiological parameters of an object (scientifically), or an aura (unscientifically).

Quite a long time ago Aristotle claimed that there is an inextricable link between movement and life. Translating this ancient statement into the modern technical language, one may say that the parameters of motor activity characterize the

state of a living object, and the parameters of micro-movements are displayed by a vibraimage. Therefore, psychophysiological informational content of vibraimage and ample opportunities of its practical use would not be surprising even to the ancient Greeks.

Health Diagnostics

Many scientists of the past found a link between physical activity and health. The principles of miokinetic diagnostics were most clearly formulated by Brazilian psychologist Mira y López. He claimed that a healthy person makes the coordinated movements, and any disease manifests itself in disorders of motion coordination. The absence of medical diagnostics based on the mode of motion is due to the fact that it is difficult to carry out the analysis of macro movements and to give a clear diagnostics of diseases depending on coordination disorders.

Recently there have appeared a number of researches in neurophysiology devoted to the analysis of movements of a person's head, the work of a vestibular apparatus and the vestibular-ocular reflex (VOR) [30]. Modern medicine rather precisely understands the mechanism of vestibular apparatus; the Nobel Prize in medicine and physiology in the distant year of 1914 was awarded to Robert Barany for his works on physiology and pathology of the vestibular apparatus (http://en.wikipedia.org/wiki/Robert_Barany). Recent researches in neurophysiology successfully solve the tasks of defining and analyzing the control signals from the nervous system to the vestibular apparatus, and the particular movements in three-dimensional space 3D, associated with these signals [31]. At the same time, the anatomical localization of the electromechanical task does not allow to consider the entire system and makes it difficult to identify common patterns.

The problem is bound also to the fact that there have not been determined common units and parameters that can objectively characterize the energy of human movement. Medical professionals and psychologists usually approach the characteristics of motion anatomically. In this case the movements determined by each individual muscle are involved in a local physiological process, and cannot be summed up and processed together. However, there are common laws of nature that govern all living and non-living objects. These are the law of energy conservation and the laws of thermodynamics. The vibraimage shows the energy of motion physically integrally, invariantly in time and space, regardless of the location of the object, and allows comparing motion parameters of various objects. The principle of obtaining the vibraimage does not allow fixing the difference between the movement of a nose, ear or cheek, i.e. the vibraimage is anatomically indifferent, which is quite unusual for a medicine. At the same time the vibraimage characterizes the movements and energy of an object entirely, as it is necessary for integral diagnostics of a person.

The most complete characteristic of a vibraimage of an object is the frequency histogram, and it was observed that a normal healthy state of a person corresponds to the normal (Gaussian) distribution of density frequency of a vibraimage of a person (fig. 29).

Of course, it is far yet not a medical diagnostics, however a routine medical examining also begins with the measurement of temperature, and normal temperature is a conventional sign of the normal state. Similarly, the normal distribution of vibration frequencies is an unmistakable sign of the normal state of a person. The majority of the facts given in this book originally had been observed experimentally and then found their theoretical explanation. It is also easy to find the

explanation of the correspondence of a normal frequency distribution to the normal state of a person.

Let us consider the basic physiological processes which lead to the formation of a vibraimage of a person. In accordance with the operation of the vestibular apparatus of the head of every man makes a three-dimensional movement to the left and to the right, and forward-back with a particular frequency. This somatic process is overlaid with the conscious movements of body (head) and facial mimic movements or gesticulations. When a person is in normal state the movements of all points of the head have approximately to the same frequency. Measurement accuracy affects the frequency detection. Since random measurement inaccuracy (with the correct system settings) has normal distribution law, the recorded value of density distribution of frequency also has normal distribution. If a person is not well, then some muscles of the neck and face make movements with the increased frequency, while the others, on the contrary, as if paralyzed, move more slowly. Normal character of measurements inaccuracy can only slightly ‘smear’ the resulting distribution but does not change its character. Thus, the frequency distribution of a vibraimage shows a noticeable maximum in the area of low frequencies if a considerable part of the face makes movements with a frequency lower than the other part of the face. Conversely, if some part of the face makes movements with a frequency above the primary, then the noticeable maximum in the area of high frequencies (fig. 29) is observed. The histograms showing frequency distribution for the opposite physiological states are provided in figure 30.

Of course, these are only the main simplified approaches to health diagnostics. Actual frequency distribution of a person’s vibraimage may have rather complex distribution determined not only by physiology but also by a psychological state of a person.

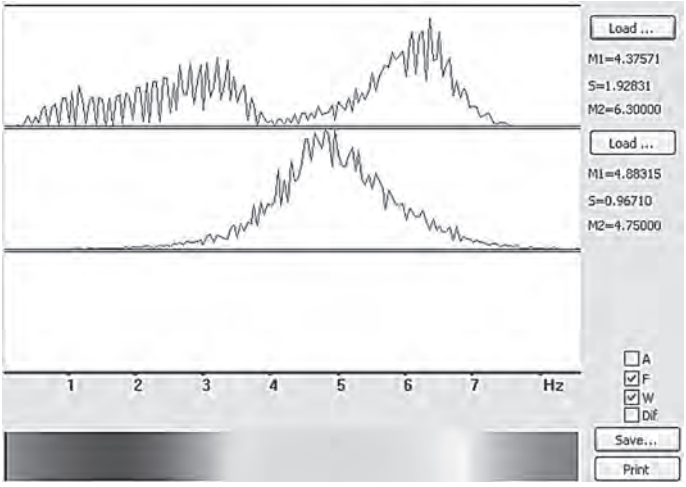


Fig. 29. *Histograms of frequency distribution of the vibraimage of a sick person (affected with flu) (top graph) and a person who is in the normal state (bottom graph)*

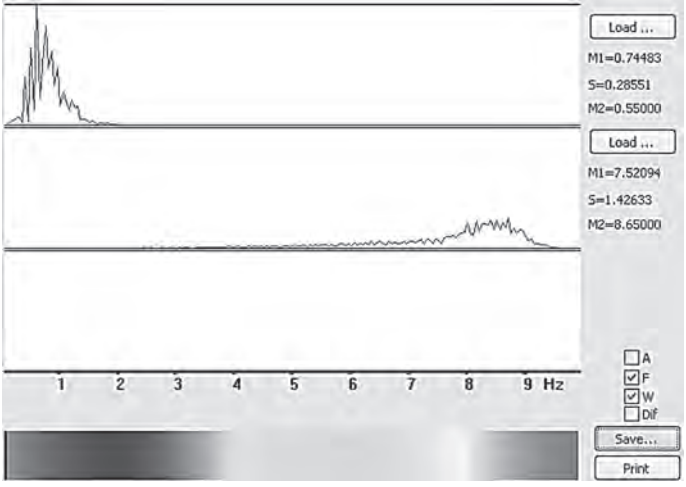


Fig. 30. *Frequency distributions typical for exhausted state (top graph) and excited state (bottom graph)*

The vestibular system interacts with the central nervous system and obtains information practically from all human organs; therefore, the disease of any organ affects both the nature of motion, and the movements while maintaining balance and equilibrium state. The deviation of the histogram of vibraimage frequency from the normal distribution law indicates a change in the mode of operation of the vestibular apparatus, which may be caused by real physiological pathology.

Unlike psychophysiological tests of Mira y López, and vestibular-ocular reflex, which analyze a person making conscious movements, vibraimage allows to analyze the psychophysiology of man not in motion but in a state of equilibrium or balance. From the view point of sensory physiology [9], the equilibrium state of a person is also a state of movement determined by the signals sent from a variety of nerve endings, and maintaining a permanent balance of motion and energy. At the same time the analysis of an object in equilibrium has a number of advantages in comparison with the analysis of macro movements, associated both with the increase in measurement accuracy, and with the increase in informational stability of the process under study.

Diagnostics of Psycho-emotional State

The mental state of a person has a significant effect on the vibraimage of a person, even minor change of a psycho-emotional state almost instantly leads to a change of energy of motion and vibraimage. And the normality of a psycho-emotional state also corresponds to the normal law of vibrations distribution, similar to physiological condition. It was found that a quiet state is characterized by low-frequency vibrations, and the increase in mental energy leads to the increase in the observed frequency of a vibraimage. Examples of psycho-

emotional diagnostics of a person's state by the frequency diagram are shown in figures 25, 26, 29 and 30.

Also it was found that the presence of irritating factors can lead to emergence of a maximum to the right of the basic or increase the area of the right side of the graph, and the presence of fatigue may lead to the appearance of the maximum in the left part from the basic or increase the area of the left (from a maximum) side of the graph. In the previous section it was argued that similar changes can be caused not by psychological, but physiological mechanisms, and this once again emphasizes the connection of the vibraimage with psycho-physiology, and not just with mentality or physiology. Of course, from the view point of diagnostics, it would be easier if the change of mentality would cause the change of some parameters of a vibraimage, and physiological changes would bring to the change of the others. But psycho-physiological processes in a human body are interrelated, and the fact that they can have identical manifestation in a vibraimage, only emphasize the inseparable connection of the vibraimage and psycho-physiology. This, of course, does not mean that it is impossible to diagnose or identify the reasons that caused the change of a person's state by means of vibraimage parameters. For this purpose it is necessary to analyze the interdependent set of parameters, proceeding from the experimental observations and common sense.

I don't want to overload this book with formulas and calculations; my task is to describe the basic principles of work of the vibraimage and the methods of calculation of psycho-physiological parameters. The technical results of parameters calculation can be found in scientific articles or technical documentation for the VibraImage system; although certain mathematics cannot be avoided there as well. Minimal technical explanations, I hope, will give the independent

reader of this book to make decisions and invent their options of vibraimage processing which do not necessarily coincide with the author's.

As the modern classification of emotional states includes a fairly large number of them, in order to make the calculation formula of the emotions and to test them in practice, the work of a huge team of both supporters and opponents of this technology and a comprehensive discussion of the obtained results are necessary. Then, perhaps, in the future, the discussion of various psycho-emotional states can be reduced to the discussion of various algorithms of calculation of motion energy and vibraimage parameters, psychology will approach medicine and the exact sciences, and we will approach a comprehension of the processes that determine a person's life.

Lie Detection

'One having eyes to see and ears to hear
can see that no mortal can keep a secret.
If his lips are silent, he talks with his fingertips;
the signs of lie oozing from every pore of his skin'.

S. Freud

The standard lie detector [6, 32] is based on the registration of changes in psycho-physiological parameters of a person (GSR, ECG, heart rate, EEG, arterial and capillary pressure, etc.) when answering a question, significant for the examinee. At the same time, it is not the lie that is registered but the nervousness of the examinee which leads to noticeable change in psycho-physiological parameters. Decoding and analysis of the recorded results are carried out by a specialist in lie detection or a specially trained psychologist. A relatively small number of input information channels (usually no more than 10) and the similarity of random and significant changes in the

parameters require numerous repetitions of the questions and attentive expert processing of results.

The vibraimage allows estimating motion parameters of each point of a body that is to some extent equivalent to the connection of contact sensors to a body of the examinee. The amount of input information of the VibraImage system is similar to the traditional polygraph with 100,000 sensors, which surpasses modern contact lie detectors more than 1000 times [33]. In the previous chapters there has been described the psycho-physiological mechanisms that determine the change of various parameters of a vibraimage, for example, the informational content of average frequency or dispersion of the vibrations. To assess the stability of a person's condition, the system of lie detection VibraLie [34], based on the vibraimage technology, records the change in time of primary parameters of a vibraimage described in chapter 8. A large amount of input information, and therefore a higher reliability of primary (main) parameters of a vibraimage allow carrying out lie detection in the automatic and/or manual mode and in real time without repeating the questions.

The automatic mode of detection of a verbal lie is provided with the algorithm including the following basic operations:

— fixation of the range (background range) of change of each of the primary parameters of a vibraimage over a definite time period (10 seconds by default) until the moment of asking a question;
— fixation of the range of change (calculation range) of each of the primary parameters of a vibraimage over the time period of asking or answering a question;
— detection of the number of primary parameters of a vibraimage which exceeded the limits of background range at the time of fixing of the calculated range.

The system detects a lie in the case when the number of vibraimage parameters which changed outside the borders of the background range exceeds the established threshold value at the time of fixing of the calculated range.

The automatic mode of detection of a nonverbal lie is provided with the algorithm including the following basic operations:

— fixation of the range (background range) of change of each of the primary parameters of a vibraimage over a definite time period (10 seconds by default) up to the current moment which constantly moves forward;
— fixation of the range of change (calculation range) of each of the primary parameters of a vibraimage over a definite time period (10 seconds) following the zero dimension;
— detection of the number of primary parameters of a vibraimage which exceeded the limits of background range at the time of fixing of the calculated range.

The system detects a lie in the case when the number of vibraimage parameters which changed outside the borders of the background range exceeds the established threshold value at the time of fixing of the calculated range.

Manual mode of detection of a verbal lie is provided with the algorithm including the following basic operations:

— fixation of the range (background range) of change of each of the primary parameters of a vibraimage over a definite time period (10 seconds by default) up to the moment determined by the operator;
— fixation of the range of change (calculation range) of each of the primary parameters of a vibraimage over the time period determined by the operator;
— detection of the number of primary parameters of a vibraimage, which exceeded the limits of background range at the time of fixing of the calculated range.

The system detects a lie in the case when the number of vibraimage parameters which changed outside the borders of the background range exceeds the established threshold value at the time of fixing of the calculated range.

Thus, with the help of the vibraimage technology it is possible to carry out automatic lie detection taking into account voice, without voice, and at certain points in time.

The detailed description and settings of system to the mode of lie detection is provided in the Technical Description of the system [35]. The display settings of the system are given below in figure 31.

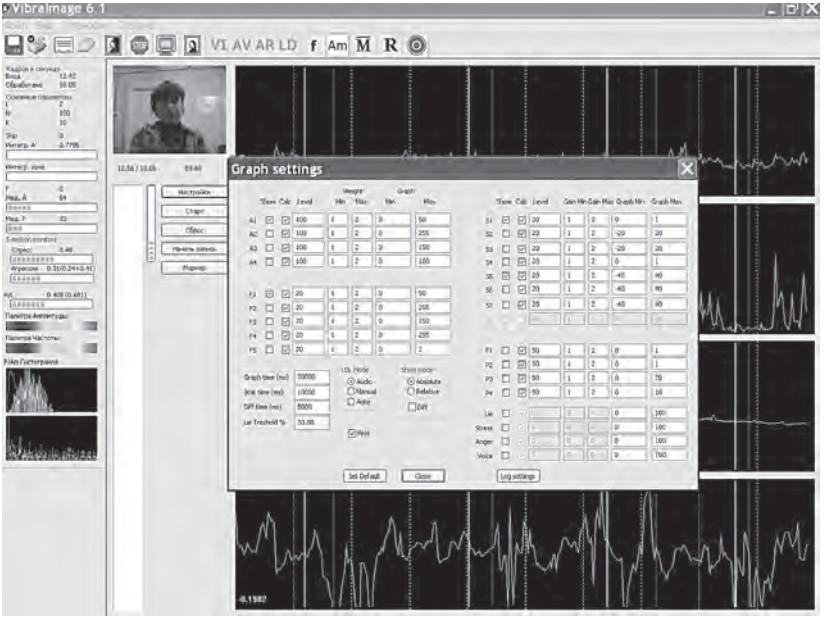


Fig. 31. *The window of lie detection program with displayed settings of the recorded vibraimage parameters*

The calculation of lie level [36] is performed by the following formula:

$$L = \frac{\sum_{1}^{m} P_{ch} \times K}{\sum_{1}^{n} P_{c} \times K},$$

where P_{ch} — the parameter that has changed more than the set limits;

P_c — the vibraimage parameter measured when determining the level of a lie;

K — coefficient of significance of the measured P_{ch};

n — the number of measured parameters;

m — the number of changed parameters.

Vibraimage parameters A1; A2; A3; A4; F1; F2; F3; F4; S1; S2; S3; S4; S5; S6; S7; P1; P2; P3; P4 can be taken out of service or adjusted in accordance with the configuration of the system.

Despite the seeming simplicity of lie detection, the work with VibraImage system requires constant attention, understanding of the basic principles of the system, and psychology. It is necessary to take into account that vibraimage parameters are the same primary psychophysiological parameters as, for example, galvanic skin response (GSR). This means that there may be no direct correlation between these characteristics, and, in some cases, a change in psycho-physiological state may not cause a change of one of the characteristics. When conducting tests, it was observed that VibraImage system often registers a lie in advance of the traditional detector, i.e. at the time of asking a question but not at the time of the response, as the physiological mechanisms responsible for thermoregulation and GSR change are more inertial, than those causing a vibraimage.

Certainly, by means of VibraImage system it is possible to process the results of the recorded video and expert (non-automatic) assessment of lie detection, similar but not always adequate to the traditional lie detection.

Security Technologies

The possibility of vibraimage technology to obtain information on a person's state can be used in the fight against terrorism and for identifying aggressive, suspicious and potentially dangerous people [26, 37, 38]. In an aggressive state the dynamics of a person's movements (psychomotor, psychodynamics) considerably changes, the work of nervous system activates, the operation frequency of the vestibular apparatus increases [9]. All of these changes can be indicated and recorded by VibraImage system remotely, in a non-contact manner, almost instantly (5s), and real-time. The minimum time period, during which the object should be in sight of the system, is limited to the time constant of the accumulated physiological processes. The maximum time of information accumulation is also limited by the macro-movements of a person, and makes no more than 30 seconds. Thus, to identify the level of aggression it is necessary to watch the person who is in one fixed place during the time period from 5 to 30 seconds; and it is quite possible, for example, at passport control, the control of access to premises, registration and purchase of tickets, etc.

VibraImage system can reveal a person who is aggressive, exited and ready to commit a crime, but of course, cannot identify the criminal who is in a calm state. Besides, it is necessary to consider a number of conditions and factors necessary for providing the adequate vibraimaging and listed in chapter 6 of this book.

The task of this book does not include the discussion of legal issues which are raised, certainly, by this technology. The future will show whether the possibility of the hidden or apparent monitoring of a person's psychophysiological state is an interference with privacy, and to what extent a crime preventing should be legally justified.

Vibraimaging and Religion

Using in one book such diverse terms as aura on the one hand, and technical and medical on the other hand, will probably annoy many readers. And dissatisfied will be both medical professionals and physicists for the use of unscientific terminology, and non-traditional researchers for the abundance of technical and medical terminology. Despite the understanding of the problem and a possible narrowing of a circle of supporters the author considers the terminology correct for the following main reasons:

The real science is characterized by a tolerance to different view points, and it is not afraid of versatile discussions [39]. If the term aura is used by various religions to characterize a person, then it is probably not so bad. Besides, the image of the aura around a person's head can have both religious and psychophysiological and physical explanation.

In modern science to create theories it is allowed using terms that have a religious meaning, if such a term is most adequately conveys the meaning of the phenomenon. For example, astronomy uses the term 'dark energy', certainly without giving it religious sense.

The vibraimaging is the technology that reflects real properties of things; perhaps, it will help to better understand the psychophysiology of a person. But it does not mean that the vibraimaging confirms or denies religion. The obtained results answer some questions and lead to others.

Vibraimage technology can be used to obtain the aura not only of people but also around the objects which are considered sacred. It should not be forgotten that a vibraimage captures mechanical vibration of any objects, and if an object has a vibration then the emergence of a vibraimage and an aura around it is just as real as its weight.

On reading prayers or at meditation the aura of a person changes (fig. 32, 33) as the psycho-physiological state of a person changes. If while in Church or during a prayer the state of a person is normalized, then this can be detected by VibraImage system. Moreover, in many religions, the prayer is directly bound to performing the periodic movements, bending the body or head which can normalize the functioning of vestibular apparatus and sensitize a person to a certain state.

The fact that when observing an aura of a person, the aura is observed only around the head of a person (approximately in 90% of examinees), says, first of all, that the head, under the control of the vestibular apparatus, makes movements (vibrations) at a frequency higher than the frequency of the movements of the body (fig. 39). Assuming the correctness of the assumption that the vibration frequency is proportional to the energy of a body's points, the logic of the ancient portrayal of the aura raises no doubts. Until recently, it was impossible to measure consciously the frequency of movements and vibrations of a human body's points; for this purpose the computer and a television camera are necessary. However, the parameters of human eyes (resolving power and dynamic range) surpass modern cameras, and the human brain is not inferior to modern computers. Therefore, if the program of vibrations calculation is inherent at the subconscious level, a person himself may well determine the frequency and amplitude of vibrations of other person. This algorithmic task is not more complicated than the recognition of a person, i.e. person identification.

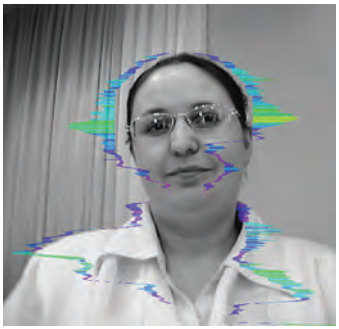
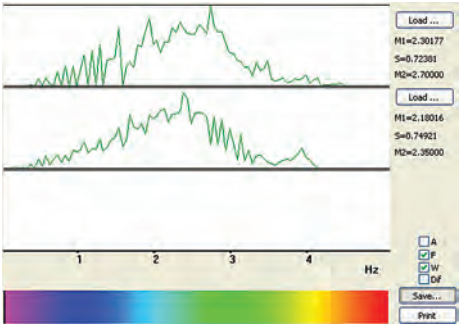
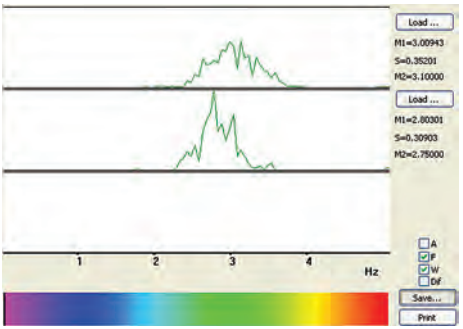


Fig. 32. *The aura of a person before, during and after meditation*





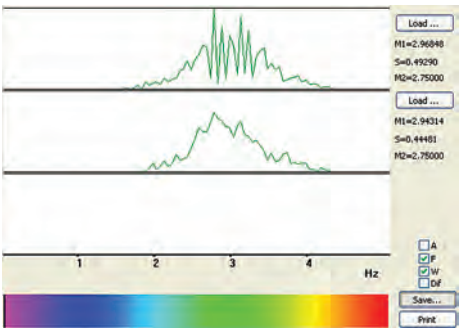


Fig. 33. *Histograms of the distribution of vibrations frequency a person before, during and after meditation*

Thus, it is quite possible to assume that under certain conditions a person can see the aura of another person. Moreover, if this characteristic is informative, then, from the perspective of human evolutionary development, energy detection can be or become necessary for ongoing development of the species. But probably, much time should pass before this function becomes consciously available for everyone. So far it is available for a few people, and not always.

Vibraimaging as a Means of Investigating Impact Factors

The vibraimage technology differs in high sensitivity from other techniques of research and detection of a person's psychophysiological state. The physiological reasons for high sensitivity are a comprehensive connection of the vestibular system with all organs and systems of man, and fact that the minimum energy is required to break the equilibrium of the complex system. The mechanical equilibrium of the human head is similar to the balance of a ball on top of a pyramid, the slightest emotional excitement causes a sideward bias of the ball, and the sensory muscular system with a certain delay restores the position of the head- ball.

High sensitivity can be both an advantage and a disadvantage, depending on the task solved. The fact that it is difficult for a person to remain in a stable psycho-physiological state, even for a short time, can also be referred to disadvantages. Any thought or look can significantly change the state of a person, and closed eyes provoke other sense organs to work more actively.

Therefore, the VibraImage system can be most effective to research the influence of weak factors on a person. These factors cannot be revealed by other methods due to insufficient

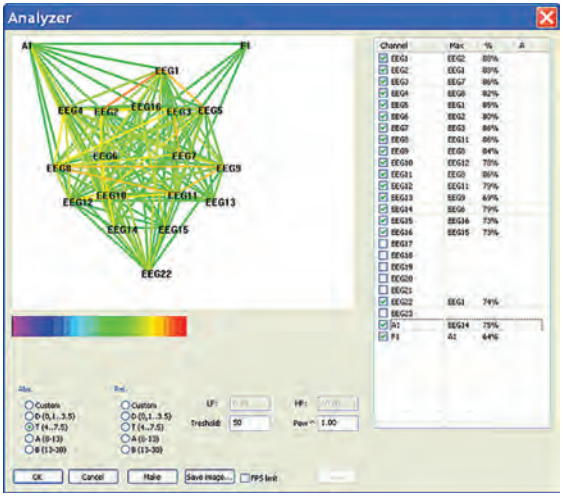


Fig. 34. *An example of the analysis of correlative connections between the parameters of the vibraimage (A1, F1) and the EEG of a person in the excited state*

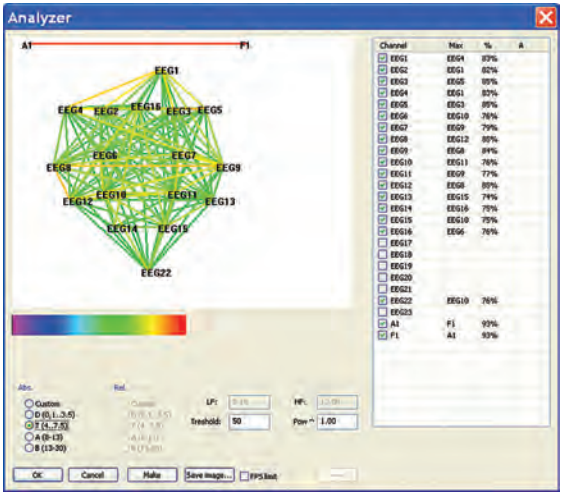


Fig. 35. *An example of the analysis of correlative connections the parameters of the vibraimage (A1, F1) and the EEG of a person in a calm state*

sensitivity. As an example, the research on the influence of a working mobile phone on a person can be regarded. It was found that after talking over a mobile phone, the density of distribution of vibraimage changes, the average frequency of vibraimage increases, and the width of dispersion of frequency of vibraimage increases (fig. 36). To increase statistical reliability the research was conducted on 10 examinees within 1 month; regular telephone conversations lasted 5 minutes. It is interesting to note that it was impossible to detect the monotonic dependence until the subject of conversation was normalized. This means that the effect of the topic of conversation sometimes exceeded the influence of phone exposure. However, when telephone conversation of the examinees was restricted to a monotonous counting, it became possible to reveal the specified regularities. A detailed report on the conducted research is given in the book [see reference # 40].

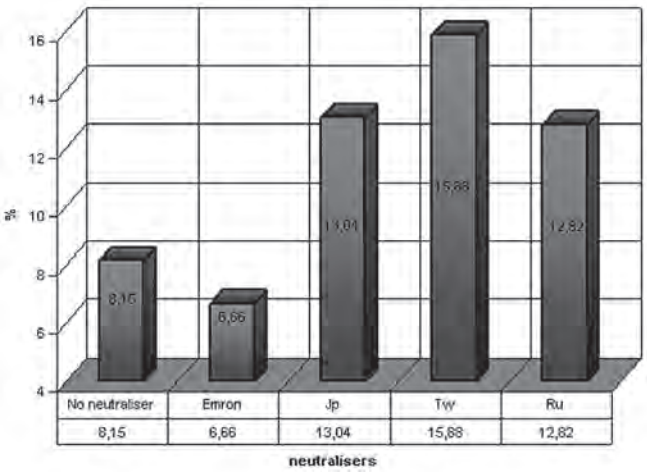


Fig. 36. *Statistical change of the width of RMSD of vibraimage frequency after a 5-minute conversation over a mobile phone with and without neutralizers*

The vibraimage technology allows monitoring a person's state in real time, i.e. to capture the change of the vibraimage at the same split second when a person's state changes. This can be determined with the help of the "fast" vibraimage parameters, for example, the parameters determined by the inter-frame difference between the adjacent frames. At the same time, of course, it is necessary to consider a possibility of influence of casual errors on the result obtained. The increase of inter-frame difference accumulation in time allows improving accuracy and reliability of measurements, but complicates the capture of fast processes. The results of research of a person's vibraimage showed that the accumulation time of about 10 s is optimal to determine a person's state with the help of the vibraimage technology.

Integrated Study of a Person's State by EEG and VI Methods

Another illustrative way of a person's psychophysiological state analysis of the changes is the study of the fast-variable parameters of vibraimage (VI) changes in time, and the correlation of EEG spectral frequencies and vibraimage signal. The signal of vibraimage fast parameters (A1, F1, S1) is an analog of low-frequency components of the electrical leads of EEG (delta, theta). The conducted study [26] showed a considerable correlation degree between EEG and VI parameters in the frequency range of theta (4–7,5) Hz for a person in an aggressive state.

Figure 37 shows the synchronous record of the vibraimage signals and an EEG signals obtained by means of the VibraEEG [31] system. The VI parameters, certainly, are more low-frequency than the EEG parameters but they can have a considerable degree of correlation in the range up to 10 Hz at a certain emotional state of a person (see fig. 34 and 35).

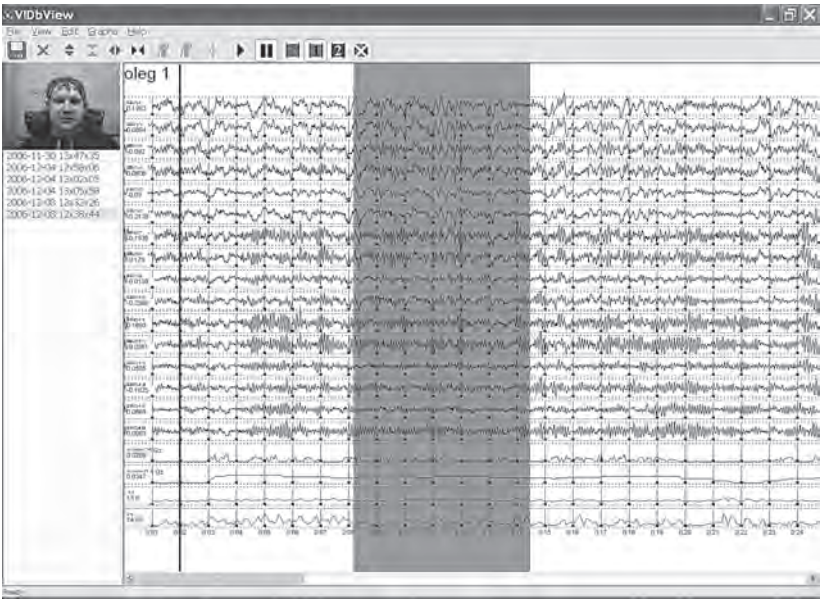


Fig. 37. *Simultaneous registration and processing of the EEG and vibraimage by the VibraEEG system.*

The following is an example of the calculation of the correlation (in the form of software window) between the EEG signals and the vibraimage signals in the frequency range θ (theta) 4–8 Hz for a person in a relaxed state (fig. 35) and aggressive state (fig. 34).

Figures 34 and 35 show the connections between the EEG electrodes (EEG1-EEG16) which conditionally (the connections color encodes correlation coefficient) indicate the correlation between the signals of electrical activity for the EEG electrodes which are located on the head of a person in a standard way. The foot point EEG22 indicates the correlation of the signals from the galvanic skin response of a human (electrode on the wrist). The top points (A1, F1) indicate correlation connections with fast signals of the

vibraimage (A1 — inter-frame difference of two frames, F1 — characteristic of the frequency change in the two frames). The tables on the right side in figures 34 and 35 show the maximum correlation coefficient for each recorded signal.

Figure 34 shows a real example of correlation connections (more than 50%) [21, 41] of signals VI (A1, F1), the signals of 16 leads of EEG (EEG1-EEG15) and the GSR signal (EEG22). It is obvious that the vibraimage parameters have a large number of correlation connections with the EEG parameters, and A1 and EEG14 parameters have maximum correlation coefficient (75%). This means that for an excited state of a person Sechenov's statement that 'all the external manifestations of brain activity can be reduced to muscular movement' is true. Therefore, the analysis of electric activity can be replaced with the analysis of a physical activity, i.e. of vibraimage.

In a calm state of a person pattern of VI and EEG correlation connections fundamentally differs from the previous one. The correlation between the VI and EEG parameters in the same frequency theta range is practically absent, i.e. when a person is in a calm state and he has no aggressive thoughts, his micro movements and the electric activity of the brain are uncorrelated (fig. 35), therefore, they are determined by different physiological mechanisms.

This simple example once again practically proves potential efficiency of the VI technology to solve the problems of a person's psychophysiological state determining.

12. VIBRAIMAGE PRO SYSTEM

The complete set of the supplied VibraImage system includes a disk with the software and the software security key for the USB port (Nowadays all latest vibraimage software is placed on Psymaker site on the link: http://www.psymaker.com/support/downloads/). The standard operating system consists of a television camera and a personal computer where the VibraImage software is installed. The detailed description of the system and the maintenance instruction are provided in the Technical description of the system for remote contactless scanning and identification of psychophysiological state of a person [35].

On the screen of the monitor the user of the system can observe the image, the vibraimage and aura of objects, make recording and processing of vibraimage parameters, define an emotional state of a person and the state of health.

The VibraImage system makes automatic monitoring of the level of emotions, such as stress, aggression and anxiety, and performs lie detection in real-time.

The VibraImage system allows analyzing the previously recorded video files (avi) and carrying out the emotional monitoring of a person in the video materials received from any source.

The VibraImage system analyzes and registers more than 20 vibraimage parameters, and suggests the user to configure the system according to the tasks, and to determine the required psycho-physiological parameters of a person.

The VibraImage program includes three independent program modules: the program to work with live video (VibraImage, fig. 40), the program for viewing the recorded videos and log files (LogViewer, fig. 41), the program for viewing and printing the archive of recorded vibraimages of patients (VIPrinter, fig. 42).

The VibraImage program allows each user having computer and web camera, to conduct personal or scientific psycho-physiological researches, and to be at the cutting edge of modern psycho-physiology. A researcher working with the system has a unique opportunity of objective monitoring of the psycho-physiological state of themselves, their families or patients by means of standard technical means.

Interpretation of External Vibraimage (aura)

Despite the fact that the VibraImage system provides users with a variety of technical parameters for registration of psycho-physiological state of a person, many users prefer to characterize a state of a person by means of an external vibraimage in the form of aura on the real image. The vibra-imaging method provides considerable freedom of choice of registration of a state; and visual observation of aura allows quickly and visually assessing practically all the psycho-physiological parameters of a person. A brief interpretation of the shapes and colors of the aura is given below. This brief information does not limit but sets the main directions for the analysis of a person's state. Gaining experience and taking into account the specifics of application, each user of the system can significantly diversify and deepen the results of the analysis of the aura, reveal the innermost secrets of the soul and body of man.

Brief Interpretation of the Aura Color

A brief interpretation of the aura color is given in figure 43.

Color unevenness of the aura characterizes the psycho-physiological imbalance of a person's condition.

Note: This brief description is true for default settings of the system and implementing the basic rules of vibraimage obtaining:

a) uniformity and stability of illuminating intensity of an object;

b) use of low-noise television cameras;

c) frontal position of an object in front of the camera;

d) maximal framing of an object's face in the monitor screen;

e) mechanical stability of the camera.

Brief Interpretation of the Aura Shape

1. Any asymmetry of aura (form, color) indicates the deviation from mental or physiological norms.
2. Any rupture in the uniformity of aura characterizes a certain deviation from psycho-physiological norms.
3. A perfect aura is one-colored, symmetrical and uniform.

Note: This brief description is true for default settings of the system and implementing the basic rules of vibraimage obtaining:

a) uniformity and stability of illuminating intensity of an object;

b) use of low-noise television cameras;

c) frontal position of an object in front of the camera;

d) maximal framing of an object's face in the monitor screen;

e) mechanical stability of the camera.

The complete description of the requirements for correct obtaining of vibraimage is given in Section 2 of the Technical Description of the system for remote contactless scanning and identification of psycho-physiological state of a person (The Component parts and the setting of the VibraImage system for obtaining a person's vibraimage).

Registration Parameters of Various States of a Person

Normal state. The normal state of a person is characterized by the uniformity of color and shape of the aura around the head, significant monochromaticism in the color scheme in the middle of the suggested color scale. The level of aggression, or more precisely, in this state, the level of activity makes 0,25–0,55. The stress level is 0,2–0,5.

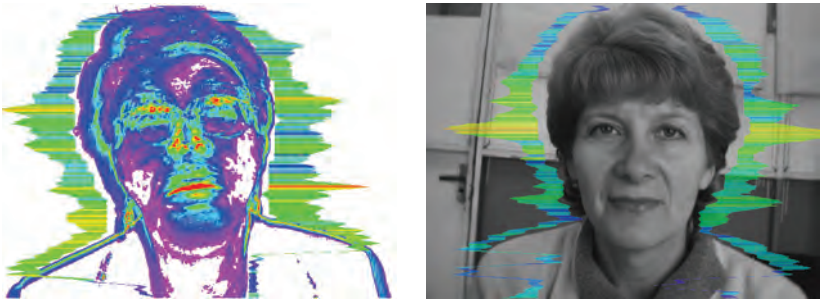
The anxiety level does not exceed 0,4.

All the levels of the parameters characterizing the emotional state are measured in the range from 0 to 1, and, of course, the minimum quantitative parameter value corresponds to the minimal intensity of emotion.

The histogram of frequency distribution is close to a normal distribution, and the range of the fast components of the vibraimage is close to the exponent.

The examples of the registration of a normal state are given in figure 44.

Stress State. The stressful state is characterized by significant gaps in the aura and significant color non-uniformity (fig. 45). In the color spectrum of the aura there are practically all colors, and the color transition is quite sharp. The blue color may adjoin the red one. The stress level is high, it is more than 0,7.



a) b)

Fig. 38. *Internal (a) external and (b) (aura) vibraimage of a person*

Fig. 39. *The image of aura (the external vibraimage) around a person*

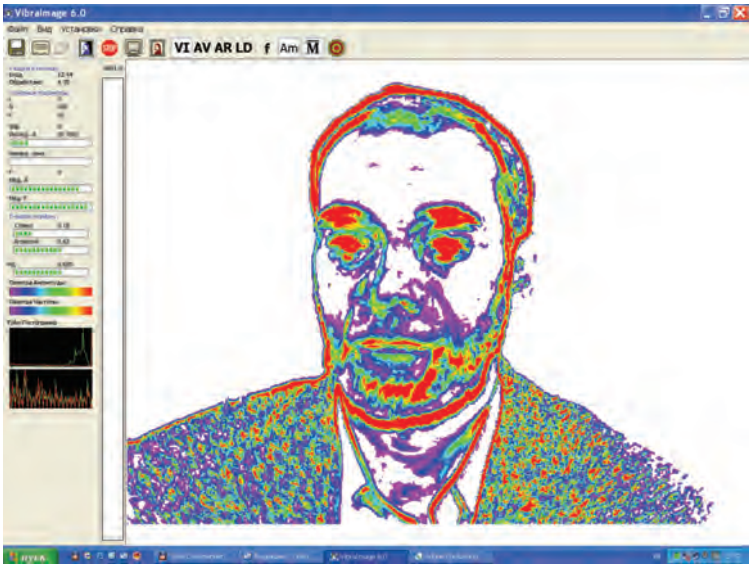


Fig. 40. *Standard window of the VibraImage program*

Fig. 41. *Standard window of the LogViewer program*

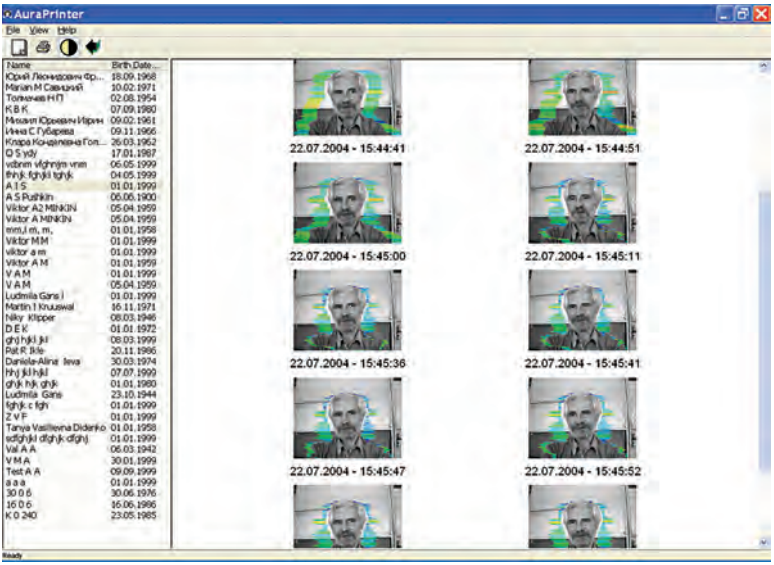


Fig. 42. *Standard window of the VIPrinter program*

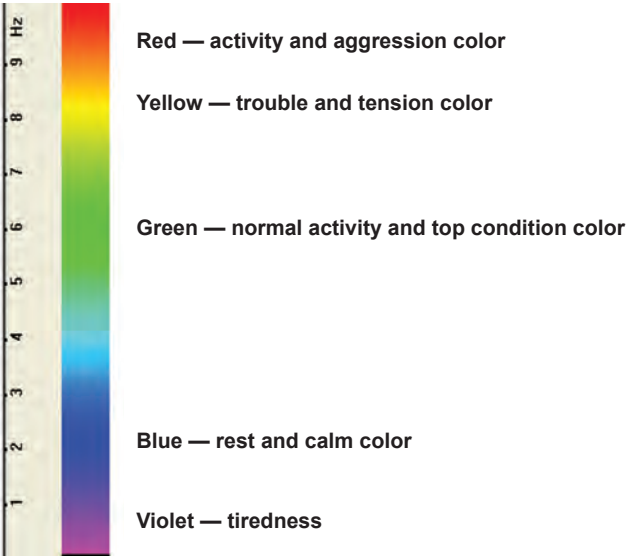


Fig. 43. *Interpretation of aura colors*

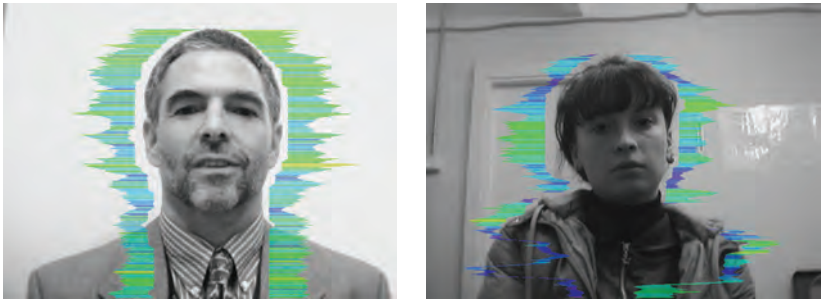


Fig. 44. *Examples of the aura for a person's normal state*

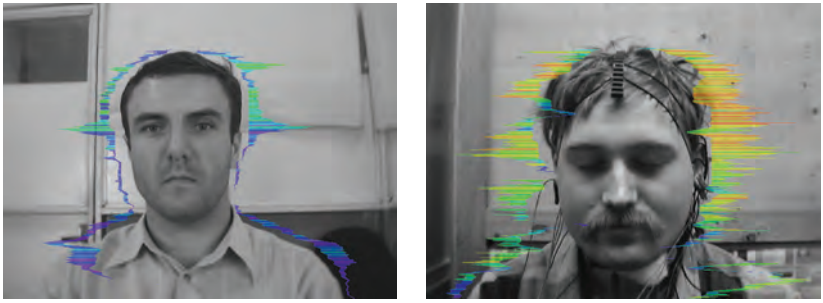


Fig. 45. *Examples of the aura for a person in a stressful state*

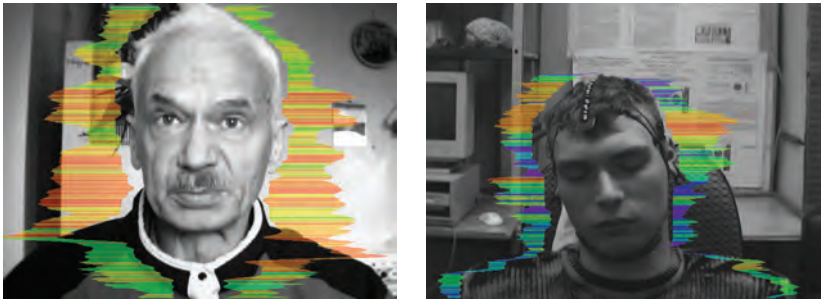


Fig. 46. *Examples of the aura for a person in an aggressive state*

At the same time, the level of aggression is usually quite low, no more than 0,5; and the level of anxiety is increased, it is more than 0,4.

The histogram of the frequency distribution has several peaks, and the range of signals represents the overlapping of exponential and uniform distributions.

Aggressive and/or Anxiety State

The aggressive state is not always anxious, and anxious state is not always aggressive. But quite often these states go hand in hand. The aggressive state is always characterized by high frequency vibrations, i.e. there are the red colors in the aura (fig. 46). The width of the aura is usually above average, and there may be no gaps, however, the color and spatial non-uniformities are always present. The stress level is usually low, no more than 0,3.

The level of aggression is above 0,7; the level of anxiety is above 0,4.

The histogram of frequency distribution has the maximum in the right part of the range, and a significant dispersion, and the envelope of the signal spectrum is close to the uniform distribution.

CONCLUSION

The vibraimage technology should find a wide application in everyday life due to the simplicity of use of the system, and the fundamental scientific theses that underlie this technology. Let us repeat the main ones.

The vibraimage is a new primary type of an image, an analog of a thermal image. It can be applied both in biology and technology, for obtaining new information on a research object, for instance, in defectoscopy, mechanical engineering, natural management, environmental management, etc.

The vibraimage of a person is a new way of research and obtaining psychophysiological information about a person. It is an electroencephalography analog but with certain advantages relating to the possibilities of non-contact and hidden information obtaining about an object.

The vibraimage is practical confirmation of the thermodynamic processes in living and inanimate objects; it combines physics, medicine and psychology into one real model.

The vibraimage is a product of modern science and technology. A few years ago it was impossible to obtain a vibraimage, therefore the vibraimage technology is only in the very beginning of its development, and in process of its development can open the new and new horizons.

Contactless and remote identification of aggression level will make a real revolution in the security systems; it will allow developing a new generation of biometric identification systems of human condition, and reconstructing legal system on monitoring of intentions of crimes commission.

Almost instantaneous monitoring of change of a person's state may find application in sociology to monitor the compatibility of people in a team and family, and that will open up new opportunities for the development of society.

Of course, the vibraimage technology has some limitations about which much has been said in this book. Only the correct use of the system and adequate analysis of the obtained results will promote successful development of the vibraimage technology. Perhaps, new research will show that the calculation formula of emotions and psycho-physiological states given in this book should be reconsidered and changed. The optimal system settings can become different. Computers will be faster, and television cameras will have lower noise level. But the assessment of psycho-physiological state of a person based on the dynamics and energy of motion by means of the vibraimage technology will take its place in the study and diagnostics of a person's state.

The analysis of motor activity of a person in equilibrium allows to characterize any emotional state by means of vibraimage parameters. This approach to emotions should significantly change the situation in psychology, bringing it essentially closer to the exact sciences and medicine. Motor activity is a behavioral function of a person, and it must be associated with an emotional state according to the principles of psychophysiology [9] and the fundamental works of the founders of modern psychology, S. Freud [3] and C. Jung [42].

Despite the consistency of the proposed approach, there certainly will be many opponents who will argue that all people are different, and there can be identical motion parameters in different states for different psychological types.

We can run endless expert discussions about the similarity of relatively close emotional states like rage and anger, calmness and fatigue, joy and happiness, etc., but since these

characteristics are subjective it is impossible to agree about the unity of the terms.

Perhaps, scientific approbation, standardization of algorithms of emotions calculation and the adoption of this approach will take more than a decade. But this is a normal evolutionary path of scientific development and, if the idea is worthwhile, then it will inevitably win. The information on the vibraimage technology as the latest achievement in the field of psychology, biometrics and medical imaging is included in the world encyclopedia Wikipedia [43].

The vibraimage is not a miracle, but an objective and integral information-energy characteristic of a person!

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