ISSN 2518-1726 (Online),
ISSN 1991-346X (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
әл-Фараби атындағы Қазақ ұлттық университетінің

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный университет
им. аль-Фараби

N E W S

OF THE NATIONAL ACADEMY OFSCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Al-Farabi Kazakh
National University

SERIES
PHYSICO-MATHEMATICAL

2(330)

MARCH – APRIL 2020

PUBLISHED SINCE JANUARY 1963

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

«ҚР ҰҒА Хабарлары. Физика-математикалық сериясы».
ISSN 2518-1726 (Online), ISSN 1991-346X (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 01.06.2006 ж. берілген **№5543-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28; 219, 220 бөл.; тел.: 272-13-19; 272-13-18,
http://physics-mathematics.kz/index.php/en/archive

Типографияның мекенжайы: «NurNaz GRACE», Алматы қ., Рысқұлов көш., 103.

«Известия НАН РК. Серия физика-математическая».
ISSN 2518-1726 (Online), ISSN 1991-346X (Print)
Собственник: РОО «Национальная академия наук Республики Казахстан» (г. Алматы).
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№5543-Ж**, выданное 01.06.2006 г.

Периодичность: 6 раз в год.
Тираж: 300 экземпляров.

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28; ком. 219, 220; тел.: 272-13-19; 272-13-18,
http://physics-mathematics.kz/index.php/en/archive

Адрес типографии: «NurNaz GRACE», г. Алматы, ул. Рыскулова, 103.

News of the National Academy of Sciences of the Republic of Kazakhstan. Physical-mathematical series.
ISSN 2518-1726 (Online), ISSN 1991-346X (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty).
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 5543-Ж, issued 01.06.2006.

Periodicity: 6 times a year.
Circulation: 300 copies.

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19; 272-13-18,
http://physics-mathematics.kz/index.php/en/archive

Address of printing house: «NurNaz GRACE», 103, Ryskulov str, Almaty.

NEWS
OF THENATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
PHYSICO-MATHEMATICAL SERIES
ISSN 1991-346X **https://doi.org/10.32014/2020.2518-1726.10**
Volume 2, Number 330 (2020), 14 – 22

UDC 004.94-57.089
IRSTI 76.13.23

T. Zh. Mazakov[1,2], Sh. A. Jomartova[1,2], Waldemar Wojcik[4], G. Z. Ziyatbekova[2], B. S. Amirkhanov[1], B. R. Zholmagambetova[3]

[1]RSE Institute of Information and Computational Technologies CS MES RK, Almaty, Kazakhstan;
[2]Al-Farabi Kazakh National University, Almaty, Kazakhstan;
[3]L. N. Gumilyov Eurasian National University, Nur-Sultan, Kazakhstan;
[4] Lublin Technical University, Poland.
E-mail: tmazakov@mail.ru, jomartova@mail.ru,waldemar.wojcik@pollub.pl, ziyatbekova@mail.ru, amirkhanov.b@gmail.com, bakhytgulz@mail.ru

UNIVERSAL COMPLEX OF PSYCHOPHYSIOLOGICAL TESTING

Abstract. An experimental version of the system of psychological testing with fixation in real time of physiological parameters of the tested person has been developed. The Data of photoplethysmogram (PPG) and galvanic skin reaction (GSR) have been determined as sources of physiological data. The soft & hardware complex of psychophysiological testing allows in relation to each question of the test to capture and evaluate the psychophysiological state of the testing person, which provides additional information for the psychologist. For experimental tests two methods were chosen, the first one was the Buss-Durkee technique (BDHI), which allows to diagnose the aggressiveness of the individual, and the second was the method of assessing the neuropsychological stability. These tests are recommended for use in psychological selection for military service [1-2]. The tests are adapted to the Kazakh language and tested on cadets of military institutions and students of civil Universities in Almaty.

Key words: electrocardiogram, photoplethysmogram, galvanic skin response, microprocessor, signal processing, psychological tests, Bass-Darki technique, personality, self-esteem level, neuropsychic stability, intellectual regulation, mental adaptation systems, validity criterion, retest method, maladaptive form of behavior, programmatically hardware complex, graphical interface.

Introduction. In the era of scientific and technological progress with its stressful rhythms andnew specific conditions of human activity significantly increasing requirements for humans intellectual, emotional and volitional resources [3-4]. In this regard, especially there is a requirement from the human resources departments of the organizations in objective psycho-physiological portrait of a person. The primery tool of psychologists are psychological tests. However, as practice shows, in connection with the public accessibility of tests, the effect of subjectivism will recently increase.

The rapid development of computer technology contributed to automate conducting and processing of psychological testing [5] and the use of new methods of mathematic treatment of biomedical data [6]. Modern possibilities for the development of various sensors [7] and price reduction of the microprocessors opened a wide opportunity for impementation of the software&hardware for assessing the psycho-physiological portrait of the individual [8-10]. The paper [11] describes a software&hardware complex of psychophysiological testing based on the processing of electrocardiogram (ECG) data. Experimental research have shown the inconvenience of using ECG sensors, because they have to be placed on the body of the test subject. This circumstance entails some discomfort for the testing person. In this regard, the decision on replacement of the ECG sensor to PPG sensor. The photoplethysmogram sensor clip on to the hand finger of the testing person and provides completeness of information comparable to the ECG data. GSR sensors are clip on two free hand fingers and do not create inconvenience for the testing person.

Research methods. A methods of psychological testing has developed with using software and hardware control of the psychophysiological state of the tested person. This circumstance significantly increases the systems objectivity of professional selection of person.

Research results. For the system of professional selection two methods were chosen, the first one was the Buss-Durkee test which allows to diagnose the personality aggressivenessand the second was the neuro-psychological stability assessment test. A system of psychological testing in Kazakh and Russian languages has been developed with recording the physiological parameters of the testing person in real time. As sources of physiological data, the data of PPG and GSR has been determined.

Software and hardware implementation. On Arduino platform [12-13] has developed a system for receiving and processing data from PPG and GSR sensors. To connect the sensors used chip AD8232 (from AnalogDevices), which is an integrated signal processing unit for ECG and other biopotential tasks [14].

A distinguishing feature of this module is its compact size and external connection to computers, its allows create a mobile diagnostic equipment. The device connects to the computer via a USB port.

The software&hardware complex of psycho-physiological testing allows capture and evaluate the psycho-physiological state of the testing person, when answering each test question. Its provides additional information for the psychologist.

At processing physiological data, the following parameters PPG and GSR are calculated, which are necessary for a mathematical model for assessing the state of the testing person: the minimum and maximum amplitude; mean value of the root mean square deviation of the amplitude. For PPG, the minimum and maximum values of the RR-interval and the minimum and maximum values of the T-peak amplitud, and also the minimum and maximum T-peak offset are additionally calculated.

The PPG sensor is analog device, based on the method of photoplethysmography - the change in the optical density of the blood volume in the finger, due to changes in blood flow through the vessels depending on the phase of the cardiac cycle. The sensor contains a light source (green LED) and a photodetector (figure 1), the voltage at which varies depending on the blood volume during cardiac pulsations.

Figure 1 - Sensor PPG

Data from the PPG sensor is received as a number characterizing the amplitude of the signal, with an intensity (frequency) of 160 samples per second. Denote by $x_i^{(k)}$- the i-th signal of the PPG related to the k-th effect (sample). Figure 2 shows a graph of the variation of the PPG over time. Figure 3 presents a general view of one period of the PPG signal.

Figure 2 - Graph of changes in the signal of the PPG

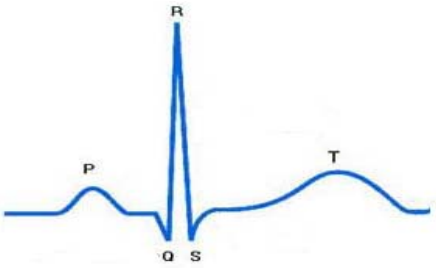

Figure 3 - General view of one period of the PPG signal

$$x_{\text{cp}}^{(k)} = \frac{1}{n_k}\sum_{i=1}^{n_k} x_i^{(k)},$$

$$x_{min}^{(k)} = \min_{i=1,n_k} x_i^{(k)},$$

$$x_{max}^{(k)} = \max_{i=1,n_k} x_i^{(k)} \qquad (1)$$

$$\sigma^{(k)} = \frac{1}{n_k}\sqrt{\sum_{i=1}^{n_k}\left(x_i^{(k)} - x_{\text{cp}}^{(k)}\right)^2},$$

$$z^{(k)} = max\left\{x_{max}^{(k)} - x_{min}^{(k)}, \sigma^{(k)}\right\}$$

For the remaining characteristics calculate following procedures are used. By reason of the signal have a periodic pattern, each separately selected RR intervalallocate. During the processing of background data, an averaged shape of the PPG signal is formed, which is typical of a particular person being tested in a calm environment. For the background averaged RR-interval denote by Yi, i = 1,100. Thus, the vector Y characterizes the shape of the individual background RR interval. In-process of the PPG data, coming in during subsequent impacts (question and answer), RR intervals are allocated respectively. Denote by Zi, i = 1, Lr. Here, Lr denotes the length of the next RR-interval. When processing the vector Z, a T-wave is distinguished, which is characterized by a shift of Lt relative to beginning of the RR interval and amplitude. The area of the RR interval is calculated - S. The value of the shift function F is calculated:

$$S = \int z(t)dt = \sum_{i=1}^{Lr} z_i\,,$$
$$F = \sum_{i=1}^{100}(y_i - z_i)^2 \qquad (2)$$

Figure 4 - Sensor GSR

As an additional parameter, the response time for each test question is analyzed.

The GSR sensor allows measuring the galvanic skin response by measuring the electrical conductivity of the skin (figure 4). Skin conduction varies with the amount of sweat on the skin. Sweaty glands are controlled by the sympathetic nervous system, which can be affect by strong emotions. Thus, strong emotions will lead to more sweating on the skin, which will lead to changes in the electrical conductivity of the skin. GSR parameters are calculated by the formulas (1).

Adaptation of psychological tests. Buss-Durkee test. Aggression - individual or collective behavior, action aimed at causing physical or psychological harm, damage, or the destruction of another person or group of people. Aggressive behavior in this case is defined as one of the forms of response to various adverse physical and mental life situations that cause stress and frustration. Aggressive actions in aggressive behavior act as a way to achieve any meaningful goal, a method of psychological relaxation, a way to satisfy the need for self-realization and self-affirmation [15].

Considering the concept of “frustration” in the framework of the psychodiagnostic approach and from the point of view of interpersonal relationship, we mean situations in which individual's surrounding persons intentionally or unintentionally infringe upon his interests, which leads to blocking significant needs or hurt feelings, negatively affecting him self-rating.

In a frustrating situation emotional state is manifested:

1) as a reaction of fear, anxiety, refusal of self-realization, may be accompanied by a sense of guilt, a desire to escape from conflict;

2) as offensive, accusing others, active or even aggressive behavior, hostile statements or actions;

3) as the desire to suppress certain reactions, to be passive or indifferent to the incident, to try to balance the severity of the conflict.

For research the level of students aggression the test by American psychologists Buss A. and Durkee A. (developed in 1957 and adapted in 1989 by Soviet and Russian psychologist S. N. Enikolopov [16]) was used.

The test was conducted among students of Kazakhstan universities. 105 people passed the Buss-Durkee test in Russian. The age of the subjects 18-30 years. Of these, 54 men and 51 women. The results obtained on 8 scales:

1) Physical aggression - the use of physical force against another person;

2) Indirect aggression - directed in a roundabout way at another person or directed at no one;

3) Irritation - readiness for the manifestation of negative feelings at the slightest excitement (short temper, rudeness);

4) Negativism - an oppositional behavior from passive resistance to active struggle against established customs and laws;

5) Resentment - envy and hatred to others for real and fictional actions;

6) Suspicion - ranging from distrust and caution towards people to the belief that other people plan and cause harm;

7) Verbal aggression - is the expression of negative feelings both through form (screaming, squeal) and through the content of verbal responses (curses, threats);

8) Guilt - expresses the subject's possible belief that he is a bad person, that evil is being done, as well as the remorse he feels.

The questionnaire consists of 75 statements, to which the subject answers “yes” or “no”.

Testing was conducted on the basis of voluntary consent. The method of Buss-Durkee in processing was very long and difficult. The obtained indices of aggressiveness and hostility can be found in the following tables:

Table 1 – Aggression index

	Below normal	Norm	Above normal
The number of tested women	7	44	0
% ratio	13,7%	86,2%	0%
The number of test men	10	38	6
% ratio	18,5%	70,3%	11%

The table shows that, on average, the index of aggressiveness in most subjects is normal, but the aggressiveness that is below the norm is observed in 17 people and mainly in mens. Indicators above the norm were found in 6 men.

Table 2 – Hostility index

	Below normal	Norm	Nbove normal
The number of tested women	4	35	12
% ratio	7,8%	68,6%	23,5%
The number of test men	0	31	23
% ratio	0	57,4%	42,5%

The table shows that a low index of hostility is observed only in 4 womens from the total number of subjects. The norm is inherent in the majority of the subjects: 23.5% of womens and 42.5% of mens were distinguished with an indicator of hostility above the norm.

The hostility index is within the normal range of 3-6 (H.I. is normal - 6-7 ± 3);

The hostility index includes the 5th and 6th scales, Hostility = Offense + Suspicion;

The index of aggression is also in the normal range of 15-20. (The norm of aggressiveness is the value of its index, equal to 21 ± 4).

Test of neuropsychological stability. Neuropsychological stability is a features that characterizes a person in the process of a complex activity, some of his emotional mechanisms, closely interacting with each other, lead to the successful achievement of goals.

The primary elements here are: the level of self-rating, emotional stability, social approval of the people around them. In the understanding of stability included the concept of reliability and functionality of reality. The stability of psychological stability depends on the realization of the individual in society, it affects the satisfaction with life, the success of professional activity and the world outlook as a whole. Decrease in neuropsychological stability leads to stressful situations with negative consequences for health and extinction of personality development in the process of life. Among the diversity of factors, there are personality traits and factors related to the social environment.

Factors of neuropsychological stability are:

- environmental factors maintaining self-rating;
- support in self-realization;
- adaptation assistance;
- reliable assistance of the social world, including from friends, relatives, colleagues.

These factors have a positive effect on neuropsychological stability in a person. Their presence forms favorable behavior in the process of professional activity and personal development of the individual.

Psychological stability is a variety of personality qualities and selected aspects of character, which are determined by endurance, poise, resilience. These qualities help to resist a person in the process of life difficulties, unfavourable circumstances, while maintaining health and effectiveness of work [17].

One of the most important criteria for entering the military service is the assessment of the level of neuropsychological stability. Assessment of neuropsychological stability and identification of persons with neuropsychological instability is an important direction in the psychological (psychophysiological) maintenance of conscripts and contract service mans in military units.

A mentally healthy is considered serviceman who is mentally qualified, staid, able to master a military specialty, to be in an organized military collective and undergo increased mental and physical stress without effect their health. There are no people absolutely immune to stress. Everyone has a strictly individual limit of resistance, after which psychoemotional stress, overwork or violation of body functions leads to a breakdown of mental activity.

To determine the "propensity for nervous breakdown in the activity of the nervous system with considerable mental and physical stress" in 1978 Spivakproposed to consider the concept of “neuropsychic instability” (NPI) [18]. Changing the rhythm of life, separation from home and family, daily routine according to military regulations, the need to obey, no privacy, increased responsibility, certain household

inconveniences, unusual climatic and geographical conditions, various occupational hazards that accompany one or another type of military labor – all of this places increased demands on the mental and physical health of military personnel. Based on the foregoing, an extremely important role in the practical work of military psychologists and specialists in professional psychological selection is assigned to an assessment of the level of neuropsychological stability of military personnel. Based on the study of servicemen serving on conscription, it was established that healthy - 61%, with some signs of neuro-mental instability - 25%, with pronounced signs of neuro-mental instability - 10%, patients - 4%.

Thus, revealing a high neuropsychic stability, we can talk about the high functional ability of the system of mental adaptation for maintaining stability and high efficiency of mental activity both under ordinary conditions and under the influence of extreme stressful environmental factors. Conversely, unsatisfactory neuropsychic stability and neuropsychic instability indicate a low functional capacity of the mental adaptation system, an increased risk in terms of the development of maladaptive mental disorders not only in extreme, but even in normal conditions of professional activity when its individual parameters change.

The technique developed in S. M. Kirov Military Medical Academy and is intended for the initial selection of persons with signs of neuropsychic instability. It allows to identify individual pre-painful signs of personality disorders, as well as to assess the probability of their evelopment and manifestations in human behavior and activity [19].

The test was conducted among cadets of military institutions and students of civil universities of Almaty. 145 people passed the test "Neuropsychic Stability (NPS)" in Russian. The subjects were 18–20 years old. All test men. The indicator on the scale of NPS is obtained by simply summing up the positive and negative answers that coincide with the “key”.

The data obtained can be found in the following table:

Table 3 – Test Results

Amount / ratio in%	Low	Average	High
The number of subjects NPS	52	78	15
% ratio NPS	35,8%	53,7%	10,3%

The test “Neuropsychic Stability” is adapted and translated into Kazakh.

When adapting the test “Neuropsychic Stability” to the Kazakh language, a certain algorithm was observed:

1) The validity of the methodology on a sample that yields statistically significant results between test indicators and the validity criterion is verified. The first results were unsatisfactory, since the correlation coefficient of -0.560 and the sample build-up did not improve it, therefore, the criterion was validated and verified by the results, the internal consistency of the test items. With the exclusion of uninformative and socially significant tasks in this situation, the desired validity was found.

2) Reliability by retest method checked. Without information on retest reliability, the test cannot be used to build a psychological forecast.

3) Analysis of correlation with relevant external criteria, with the author's criteria has been performed.

4) Test standards after checking the sustainability of the obtained distribution of test scores were checked.

As a result, it was found that it is personal and biological factors that influence the development of neurotic disorders. It should be noted that individuals, military personnel with signs of neuro-psychic instability require special attention of a psychologist. Mental states can have the opposite effect on personality, its development and dynamics, the formation of some properties and the weakening of others, changes in the structure of motives, goals and activities. Individuals with neuropsychic instability are at risk group. There is a high probability of disadaptive forms of behavior.

Conclusion. A software&hardware complex for psychophysiological testing has been developed, which allows recording and assessing the psychophysiological state of the test person when answering

each test question. The graphical user interface of the application is implemented in the Kazakh and Russian languages. The techniques of Buss-Durkee and assessment of neuropsychic stability are automated and adapted to the Kazakh language.

It is expected to use a software&hardware complex for obtaining a psychophysiological portrait of a person when hiring in state and private organizations, as well as for service in law enforcement agencies.

Acknowledgment. The work was carried out at the expense of grant funding for research for 2018-2020 under the project № AP05132044 “Development of a hardware-medical complex for assessing the psycho-physiological parameters of a person” at the Institute of Information and Computational Technologies, the Committee of science of the Ministry of Education and Science of the Republic of Kazakhstan.

Т.Ж. Мазаков[1,2], Ш.А. Джомартова[1,2], Waldemar Wojcik[4], Г.З. Зиятбекова[2], Б.С. Амирханов[2], Б.Р. Жолмагамбетова[3]

[1]Ақпараттық және есептеуіш технологиялар институты, Алматы, Қазақстан,
[2]әл-Фараби атындағы Қазақ ұлттық университеті, Алматы, Қазақстан,
[3]Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Нұр-Сұлтан, Қазақстан,
[4]Люблин техникалық университеті, Польша

ПСИХОФИЗИОЛОГИЯЛЫҚ ТЕСТІЛЕУДІҢ ӘМБЕБАП КЕШЕНІ

Аннотация. Мақалада психофизиологиялық тестілеудің аппараттық-бағдарламалық кешенін (АБК) қолданудың өзекті мәселесі қарастырылады. Нақты уақытта тестілеудің физиологиялық параметрлерін анықтай отырып, психологиялық тестілеу жүйесінің тәжірибелік нұсқасы жасалды. Физиологиялық деректердің көзі ретінде тері-гальваникалық реакцияның (ТГР) фотоплетизмасының (ФП) мәліметтері анықталды. Arduino платформасында фотоплетизма және тері-гальваникалық реакция сенсорларынан мәліметтерді қабылдау және өңдеу жүйесі жасалды. Фондық деректерді өңдеу кезінде тыныш жағдайда нақты сынақ жүргізушіге тән ФП сигналының ортаңғы формасы қалыптасады. Тақырыптың психофизиологиялық жағдайының өзгеруімен (мысалы, стресс жағдайында) тыныс алу жылдамдайды немесе азаяды (ол RR интервалдарының мөлшерін өзгерту арқылы белгіленеді), R шыңының амплитудасы төмендейді («таралады» сигналы), T шыңының амплитудасы мен позициясы өзгереді. Осы белгілердің барлығы бағдарламалық түрде анықталады және тақырыпты диагностикалауда қолданылады. Психофизиологиялық тестілеудің аппараттық-бағдарламалық кешені тесттің әр сұрағына жауап берген кезде психологқа қосымша ақпарат беретін тестілеуші адамның психофизиологиялық жағдайын тіркеуге және бағалауға мүмкіндік береді. Қойылған міндет психологиялық тестілеу арқылы шешілетін міндеттердің біріне қатысты. Агрессивті мінез-құлықпен агрессивті әрекеттер кез-келген маңызды мақсатқа жетудің тәсілі, психологиялық релаксация, өзін-өзі тану және өзін-өзі растау қажеттілігін қанағаттандыру тәсілі ретінде әрекет етеді. Тұлғалық ерекшеліктер эмоционалды күйзеліс жағдайында айқын көрінеді. Сондықтан психологтар ашушаңдық жағдайындағы адамның реакциясын мұқият зерттейді. Авторлар осы тақырып бойынша талдау жүргізді, эксперименттік тесттің әртүрлі әдістерін, мысалы, нейропсихикалық төзімділікті бағалау әдістемесін қарастырды. Бұл жағдай кәсіби тұлғаны таңдау жүйесінің объективтілігін едәуір арттырады. Тесттің физиологиялық параметрлерін белгілейтін психологиялық тестілеу жүйесінің тәжірибелік нұсқасы жасалды. Эксперименттік сынақтар ретінде жеке басының агрессивтілігін диагностикалауға мүмкіндік беретін Басс-Дарка әдісі және нейропсихикалық төзімділікті бағалау әдістемесі таңдалды. Американдық психологтар А. Басс және А. Дарка сынақтарын қолдана отырып студенттердің агрессиялық деңгейіне зерттеу жасалды. Психологиялық тұрақтылықтың орнықтылығы қоғамдағы жеке тұлғаның жүзеге асырылуына байланысты, ол өмірге қанағаттануға, кәсіби қызметтің жетістіктеріне және тұтастай алғанда дүниетанымға әсер етеді. Нейропсихикалық төзімділіктің төмендеуі денсаулыққа теріс әсер ететін стресстік жағдайларға және өмір процесінде жеке тұлғаның дамуының жойылуына әкеледі. Әр түрлі факторлардың ішінде жеке тұлғалық ерекшеліктер мен әлеуметтік ортаға байланысты факторлар бар. Бұл мәселені шешу үшін жауаптарды жазып, тесттің психофизиологиялық жағдайын бағалайтын аппараттық-бағдарламалық кешенді қолдана отырып психофизиологиялық тестілеуді қолдану ұсынылады. Осылайша, жоғары нейропсихикалық тұрақтылықты анықтай отырып, біз психикалық бейімделу жүйесінің қалыпты жағдайдағы сияқты, сонымен қатар экстремалды факторлардың әсерінен де тұрақтылықты және ақыл-ой әрекетінің жоғары тиімділігін сақтай алатын жоғары функционалды қабілеті туралы да айта аламыз. Қосымша параметр ретінде әр тест сұрақтарына жауап беру уақыты талданады. Қосымшаның графиктік интерфейсі қазақ және орыс тілдерінде жүзеге асырылады.

Берілген мысал психофизиологиялық тестілеудің аппараттық-бағдарламалық кешенін қолдану тесттің әр сұрағына жауап бергенде нақты уақыт режимінде тестілеуші адамның физиологиялық параметрлерін тіркеуге және бағалауға мүмкіндік беретіндігін көрсетеді. Жоғарыда аталған жағдайлардың әдіснамасын қолдана отырып, кәсіпқой жеке тұлғаны таңдаудың объективті жүйесін құру ұсынылады. Бұл сынақтар әскери қызметке психологиялық таңдау кезінде пайдалануға ұсынылады [1-2]. Тесттер қазақ тіліне бейімделіп, Алматы қаласындағы әскери оқу орындарының курсанттары мен студенттері арасында сынақтан өткізілді. Ұсынылған аппараттық-бағдарламалық кешен негізінде жасалған алгоритмдермен әзірленген бағдарламалық жасақтама тестілеуші адамның психофизиологиялық жағдайын бағалау үшін инвариантты екенін көрсетті.

Түйін сөздер: электрокардиограмма, фотоплетизм, тері-гальваникалық реакция, микропроцессор, сигналды өңдеу, психологиялық тесттер, Басс-Дарки әдісі, жеке тұлға, өзін-өзі бағалау деңгейі, нейропсихикалық тұрақтылық, интеллектуалды реттеу, психикалық бейімделу жүйелері, жарамдылық критерийі, ретест әдісі, зиянды мінез-құлық, аппараттық-бағдарламалық кешен, графиктік интерфейс.

Т.Ж. Мазаков[1,2], Ш.А. Джомартова[1,2], Waldemar Wojcik[4],
Г.З. Зиятбекова[2], Б.С. Амирханов[2], Б.Р. Жолмагамбетова[3]

[1]Институт информационных и вычислительных технологий КН МОН РК, Алматы, Казахстан;
[2]Казахскийнациональный университет имени аль-Фараби, Алматы, Казахстан;
[3]Евразийский национальный университет имени Л.Н. Гумилева, Нур-Султан, Казахстан;
[3]Люблинский технический университет, Польша

УНИВЕРСАЛЬНЫЙ КОМПЛЕКС ПСИХОФИЗИОЛОГИЧЕСКОГО ТЕСТИРОВАНИЯ

Аннотация. В статье рассматривается актуальная проблема применения программно-аппаратного комплекса (ПАК) психофизиологического тестирования. Разработан экспериментальный вариант системы психологического тестирования с фиксированием физиологических параметров тестируемого в реальном времени. В качестве источников физиологических данных определены данные фотоплетизмограммы (ФП) кожно-гальванической реакции (КГР). На платформе Arduino разработана система приема и обработки данных с датчиков фотоплетизмограммы и кожно-гальванической реакции. Во время обработки фоновых данных формируется усредненная форма сигнала ФП, свойственная конкретному тестируемому в спокойной обстановке. При изменении психофизиологического состояния исследуемого (например, при стрессе) учащается или становится реже дыхание (что фиксируется изменением размаха RR-интервалов), уменьшается амплитуда R-пика (сигнал “размазывается”), изменяется амплитуда и положение Т-пика. Все перечисленные признаки определяются программно и используются при диагностике исследуемого. Программно-аппаратный комплекс психофизиологического тестирования позволяет при ответе на каждый вопрос теста фиксировать и оценивать психофизиологическое состояние тестируемого, что дает дополнительную информацию для психолога. Поставленная задача относится к одной из задач, решаемых при помощи психологического тестирования. Агрессивные действия при агрессивном поведении выступают как способ достижения какой-либо значимой цели, способ психологической разрядки, способ удовлетворения потребности в самореализации и самоутверждении. Особенности личности проявляются ярче в состоянии эмоционального напряжения. Поэтому психологи внимательно изучают реакции индивида в ситуации фрустрации. Авторам проведен анализ по данной тематике, рассмотрены различные методы экспериментального теста, например, методика оценки нервно-психической устойчивости. Данное обстоятельство существенно повышает объективность системы профессионального отбора личности. Разработан экспериментальный вариант системы психологического тестирования с фиксированием физиологических параметров тестируемого. В качестве экспериментальных тестов выбраны методика Басса-Дарки, позволяющая диагностировать агрессивность личности, и методика оценки нервно-психической устойчивости. Проведено исследование уровня агрессии студентов с использованием теста американских психологов А. Басса и А.Дарки. Предложено решение этой проблемы с использованием ПАК психофизиологического тестирования, которое фиксирует ответы и оценивает психофизиологическое состояние тестируемого. Стабильность психологической устойчивости зависит от реализации личности в социуме, она оказывает влияние на удовлетворение жизнью, на успешность профессиональной деятельности и мировоззрение в целом. Снижение нервно-психической устойчивости ведет к появлению стрессовых ситуаций с отрицательными последствиями для здоровья и угасанию развития личности в процессе жизни. Среди разнообразия факторов существуют личностные особенности и факторы, связанные с социальной средой. Так, выявляя высокую нервно-психическую устойчивость, можно говорить о высокой функциональной способности системы психической адаптации по сохранению устойчивости и высокой эффективности психической деятельности как в обычных условиях, так и в условиях воздействия

экстремальных стрессовых факторов внешней среды. В качестве дополнительного параметра анализируется время ответа на каждый вопрос теста. Графический интерфейс пользователя приложения реализован на казахском и русском языках.

Приведенный пример показывает, что использование программно-аппаратного комплекса психофизиологического тестирования позволяет при ответе на каждый вопрос теста фиксировать и оценивать физиологические параметры тестируемого в реальном режиме времени. Предложено решение этой проблемы с использованием методики вышеизложенных обстоятельств, которые диктуют необходимость в создании объективной системы профессионального отбора личности. Указанные тесты рекомендуются для применения при психологическом отборе на военную службу [1-2]. Тесты адаптированы на казахский язык и апробированы на курсантах военных заведений и студентах гражданских вузов г. Алматы. Предложенные автором алгоритмы, созданные на основе предложенного ПАК, показали, что разработанная программная система обладает инвариантностью к оцениванию психофизиологического состояния тестируемого.

Ключевые слова: электрокардиограмма, фотоплетизмограмма, кожно-гальваническая реакция, микропроцессор, обработка сигналов, психологические тесты, методика Басса-Дарки, личность, уровень самооценки, нервно-психическая устойчивость, интеллектуальная регуляция, системы психической адаптации, критерий валидности, метод ретеста, дезадаптивная форма поведения, программно-аппаратного комплекс, графический интерфейс.

Information about authors:

Mazakov T.Zh., Dr. Sci. Phys.-math., Institute of Information and Computational Technologies; tmazakov@mail.ru; https://orcid.org/0000-0001-9345-5167;

Jomartova Sh.A., Dr. Sci. Tech, Institute of Information and Computational Technologies; jomartova@mail.ru; https://orcid.org/0000-0002-5882-5588;

Waldemar Wojcik, Professor of Lublin University of Technology (Lublin, Poland);waldemar.wojcik@pollub.pl;

Ziyatbekova G.Z., doctoral student, Al-Farabi Kazakh National University; ziyatbekova@mail.ru; https://orcid.org/0000-0002-9290-6074;

Amirkhanov B.S., doctoral student, Al-Farabi Kazakh National University; amirkhanov.b@gmail.com; https://orcid.org/0000-0002-4915-0347;

Zholmagambetova B.R., doctoral student, L.N. Gumilyov Eurasian National University; bakhytgulz@mail.ru

REFERENCES

[1] Baranov Y. A. mental instability and methods to identify recruits // actual problems of OPS and the efficient allocation of conscripts in military commissariats. M.: the USSR Ministry of defense, 1988. 183 p.

[2] The system of the organization of psychophysiological actions in Armed Forces of the Russian Federation // the author's abstract of the doctoral dissertation on special. 19.00.02 – Psychophysiology, St. Petersburg, 2011. 49 p.

[3] Nurdaulet, I., Talgat, M., Orken, M., Ziyatbekova, G. Application of fuzzy and interval analysis to the study of the prediction and control model of the epidemiologic situation // Journal of Theoretical and Applied Information Technology, Pakistan, – Vol. 96, Issue 14, 31 July 2018, P. 4358-4368.

[4] Mamyrbayev O. Zh., Shayakhmetova A. S., Seisenbekova P. B. The methodology of creating an intellectual environment of increasing the competence of students based on a bayesian approach // News of the National academy of sciences of the republic of Kazakhstan. Series physico-mathematical. 2019. Vol. 4, N 326. P. 50-58. ISSN 2518-170X (Online). ISSN 1991-346X (Print). https://doi.org/10.32014/2019.2518-1726.43

[5] Duke V. A. computer psychodiagnosis. –SPb.: Brotherhood, 1994. 364 p.

[6] Dontsov V.I., Krutko V.N., Kudashov A.A. Virtual instruments in biology and medicine. M.: Lenand, 2009. 216 p.

[7] Sharapov V.M., et al. observation Equipment. – Moscow: Technosphere, 2012. 624 p.

[8] Kalachev A. P. Computer electrophysiology and functional diagnostics. M.: Forum, IRFA-m, 2010. 640 p.

[9] New methods of electrocardiography // Ed. Grachev S. V., Ivanov G. G., Sarcina A. L. M.: Technosphere, 2007. 552 p.

[10] Dmitrieva N.V. System of surgery. System analysis of electrophysiological processes. M.: Sainz-press, 2008. 256 p.

[11] B.S. Amirkhanov, G. D. Daribaeva, B.R. Zholmagambetova, G.Z. Ziyatbekova, A.T. Mazakova, B.K. Abdirazak. Hardware-software complex for psychophysiological testing // Vestnik KazUTB, Nur-Sultan-2019, N. 1, P. 2-9.

[12] Petin V. A projects using the Arduino controller. - SPb.: BHV-Petersburg, 2014. 400 p.

[13] Boxell J. Studying Arduino. 65 projects with their own hands. – SPb.: Peter, 2017. 400 p.

[14] Rangayan R. M. Analysis of biomedical signals. Practical approach. - M.: Fizmatlit. 2010. 440 for voice acting.

[15] Psychological tests for professionals // Compiled by B.F. comb. Minsk: let's do it. School-2007. 496 p.

[16] Hwang, A. A., Zaitsev A. Yu., Kuznetsov Yu. A. Standardization of the questionnaire A. Bassa and darki A. // psychological diagnostics, 2008, N. 1, P. 35-58.

[17] Karayani A. G. Syromyatnikov I. V., Applied military psychology. SPb.: Peter, 2006. 480 p.

[18] Spivak L. I. Altered States of consciousness in healthy people (question, research prospects) // human physiology, 1988. Vol. 14, N1, P. 138-147.

[19] Berg T.N. Neuropsychiatric instability and methods of its detection. Vladivostok: Maritime State University, 2005. 63p.

Publication Ethics and Publication Malpractice
in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see **http://www.elsevier.com/publishingethics** and **http://www.elsevier.com/journal-authors/ethics**.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see **http://www.elsevier.com/postingpolicy**), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (**http://publicationethics.org/files/u2/New_Code.pdf**). To verify originality, your article may be checked by the Cross Check originality detection service **http://www.elsevier.com/editors/plagdetect**.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

(Правила оформления статьи для публикации в журнале смотреть на сайтах:

www:nauka-nanrk.kz

http://physics-mathematics.kz/index.php/en/archive

ISSN 2518-1726 (Online), ISSN 1991-346X (Print)

Редакторы: *М. С. Ахметова, Г. Б. Халидуллаева, Д. С. Аленов*
Верстка на компьютере *А.М. Кульгинбаевой*

Подписано в печать 05.04.2020.
Формат 60x881/8. Бумага офсетная. Печать – ризограф.
11 п.л. Тираж 300. Заказ 2.

Национальная академия наук РК
050010, Алматы, ул. Шевченко, 28, т. 272-13-18, 272-13-19