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Informational Models of Machine Education Learning: Systems for Safe Diagnosis of Emotional and Psychological States

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Abstract

The purpose of the study is to increase the functional efficiency of a diagnostic decision support system capable of machine engineering learning to determine the emotional and mental state of a person from an image of his face. The object of the study is information models of machine engineering learning. The scientific task is to increase the accuracy and efficiency of assessing the current level of stability and the influence of stress, fatigue and other factors through modern models of machine engineering learning. The methodology involves the use of IEI (information-extreme intelligent technology) technology and functional analysis methods to construct categories of machine engineering learning models. As a result, functional category models of information-extreme machine engineering learning were proposed using the basic method of IEI technology and optimization of the system of control tolerances, reflecting the transformations of information and information flows occurring during the cognitive processes of formation and decision-making. These models will be used to determine the emotional and psychological state of a person under arbitrary initial conditions for performing individual diagnostic actions. The most important limitation regarding our study, in our opinion, is the dependence of accuracy in diagnosing an emotional and psychological state on the quality of the images subject to analysis. Using only facial images may not take into account other important aspects of nonverbal communication such as gestures and posture, which may reduce the overall effectiveness of the system. Taking into account certain limitations, we have identified a number of promising areas for further research. Thus, in future studies it is planned to include the analysis of video recordings and other sources that allow us to analyze the emotional spectrum of a person. In addition, it is planned to add biometric research methods to the study.

Keywords: *Machine Engineering Training, Decision Support System, Information Models, Emotional and Psychological State, IEI Technologies, Functional Analysis, Cognitive Processes, Information-Extreme Intelligent Technology, Pegapogy*

INTRODUCTION

Modern engineering technologies, in particular in the field of artificial intelligence and machine learning, are opening up new horizons in recognizing people's emotions. The ability of computer systems to analyze facial expressions, tone of voice and other non-verbal signs of emotional states is becoming increasingly sophisticated. This is achieved through the use of powerful image and audio processing algorithms that can detect subtle changes in facial expression and other physiological characteristics.

The key modern trend in this area is the integration of technologies that make it possible to recognize, read and analyze emotions in different areas of human life: from entertainment and marketing to the medical field. For example, in the medical field, these technologies can become an integral part of the diagnostic process. These technologies, in a short period of time and without lack of subjectivity and the human factor, can analyze hundreds of emotions, identifying psychophysiological states, problems and other changes in the behavior and emotional spectrum of the patient. The vector of using these technologies in the field of education may be

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interesting. In this area, these technologies can help analyze the readiness or unpreparedness of students to master certain volumes of materials, as well as maintain their psycho-emotional state in a normal manner.

Thus, modern engineering technologies for emotion recognition have great potential and are already changing many aspects of our lives. However, to fully realize their capabilities, it is necessary to solve a number of technical and moral problems. Integrating these technologies into everyday life will increase, opening up new opportunities to improve the quality of life and the efficiency of various processes.

The transportation system and logistics planning for Modern machine learning technologies are rapidly developing and are widely used in various fields, in particular in psychology and psychiatry. The use of machine-engineering learning models to analyze the psychological and mental state of a person opens up new prospects for diagnosing and treating disorders. One of the most important aspects is the ability of these models to automatically determine the level of stress, fatigue and other psycho-emotional states from the face, which allows for faster and more accurate diagnostic decisions.

The essence of any modern training model lies in their ability to self-learn and self-improvement. Such processes will ensure high quality forecasts and analyzes in the long term and the ability to analyze large volumes of data in context. This is especially true for analyzing a person's psychological state, where the accuracy of the diagnosis may depend on many factors, including facial expressions that reflect emotional states. Machine learning models can effectively process this data, highlighting key features of stress or fatigue indicators.

Using the models described above has significant promise and long-term benefits. First of all, the introduction of these automated processes in the field of medicine will minimize subjective errors and the human factor in the diagnostic process. In addition, further development of these technologies, the formation of a simple and understandable interface for them, as well as their adaptation to various devices will make such analysis almost continuous and in real time. This is especially true for people whose life or work involves frequent stressful situations.

Another problem is the moral aspects of using such systems. The collection and processing of biometric data requires compliance with high standards of confidentiality and protection of personal information. Ensuring data security is a key factor in user trust in such technologies. For example, adding data on voice analysis, physiological characteristics (heart rate, cortisol levels, etc.) can significantly increase the accuracy of diagnosis. An interdisciplinary approach combining knowledge from psychology, biomedical sciences and information technology will create more comprehensive and reliable diagnostic systems.

As a result, the use of machine-engineering learning models in the process of analyzing a person's psychological and mental state opens up significant opportunities for increasing the efficiency and accuracy of diagnosis. However, to fully realize these opportunities, existing challenges must be overcome, in particular regarding data quality and the ethical aspects of their use. Systems that consider these factors can become an integral part of modern diagnostic practice, providing better and more timely medical care.

Thus, the purpose of the study is to increase the functional efficiency of a diagnostic decision support system capable of machine engineering learning to determine the emotional and mental state of a person from an image of his face. The object of the study is information models of machine engineering learning.

LITERATURE REVIEW

Analysis of scientific publications allows us to identify the most effective approaches and innovative technologies that have already shown their effectiveness in different contexts. In addition, understanding current advances and challenges in the field helps identify knowledge gaps and directions for further research, which facilitates the development of better machine learning models and their implementation in medical practice.

For example, Zainudin et al. (2021) conducted a comprehensive study that concerned the selection of the most optimal stress detection technologies in the context of analyzing the effectiveness of machine learning. The conclusions drawn by the authors prove that the use of machine-engineering learning technologies will make it possible to more accurately and without human errors determine the level of stress through biometric data and non-verbal signs. No less interesting is the study by Garriga et al. (2022), who were able to create their own machine learning model that could predict crises in the psycho-emotional state of patients based on data from their medical records. The results obtained proved the effectiveness of technologies and automated algorithms for analyzing the psycho-emotional state and determining stress conditions.

Abd-alrazaq et al. (2023) reviewed the effectiveness of artificial intelligence-based technologies for diagnosing mental disorders. Their analysis showed that artificial intelligence can provide high accuracy in identifying various mental states. This study highlights the importance of using artificial intelligence to improve diagnostic accuracy and reliability, which is the basis of our research.

Alharthi (2023) explored the use of artificial intelligence technologies to predict rates of generalized anxiety disorder among college students during the COVID-19 pandemic. His research showed that artificial intelligence algorithms can effectively predict anxiety levels based on various factors. This study is important for our work because it demonstrates the feasibility of using AI to assess anxiety in different contexts. Anand et al. (2023) focused on improving diagnostic decision making through ensemble learning methods for stress level classification. Their study showed that ensemble methods can provide more reliable stress classification compared to individual algorithms. This study is important to our project because it highlights the benefits of using comprehensive machine learning approaches to improve diagnostic accuracy.

Reddy et al. (2018) explored machine learning techniques to predict stress among working employees. Their results showed that machine learning algorithms can accurately predict stress levels based on work parameters and behavioral data. This study is valuable to our work because it confirms the effectiveness of using machine learning to monitor stress in work environments.

Wu et al. (2023) systematically explored the use of machine learning to automatically diagnose post-traumatic stress disorder (PTSD). Their analysis showed that the use of machine learning algorithms significantly improves the accuracy of PTSD diagnosis. This study is important for our work because it demonstrates the capabilities of automated psychiatric diagnostic systems, confirming the effectiveness of machine learning methods in determining psycho-emotional states. Gavrilescu and Vizireanu [8] developed a methodology for predicting levels of depression, anxiety and stress from video recordings using the Facial Action Coding System (FACS). Their results indicate the high accuracy of such predictions, which confirms the feasibility of using video data to analyze the psycho-emotional state. This study is important for our project because it confirms the possibility of using different types of data to improve diagnostic accuracy.

Li et al.(2022) studied the prediction of PTSD symptoms in firefighters using the startle start paradigm and machine learning. Their research showed that machine learning algorithms can effectively predict PTSD symptoms based on physiological responses. This study highlights the importance of incorporating physiological data into machine learning models to more accurately diagnose psycho-emotional states, a critical aspect of our research.

Gagnon-Sanschagrin et al. (2022) developed a machine-learning approach to identify individuals with undiagnosed PTSD in a large US civilian population. Their results indicate high accuracy in detecting PTSD using automated systems, confirming the effectiveness of such methods in large-scale studies. This study is useful for our project because it demonstrates the potential of machine learning in diagnosing psychoemotional disorders at the population level.

Priya et al. (2020) investigated the prediction of anxiety, depression and stress in modern life using machine learning algorithms. They developed models that showed high accuracy in identifying these conditions based on various data. This study is important for our work because it highlights the possibility of using various machine learning algorithms for a comprehensive analysis of psycho-emotional states in everyday life.

Despite significant and significant research conducted in the field of diagnosing emotional and psychological states using machine learning, this area remains insufficiently studied. Although current methods demonstrate high accuracy and efficiency, there are some scientific gaps that require further research (Table 1).

Table 1. Key scientific gaps and shortcomings of the researched topic

Scientific gaps and shortcomings	Essence
Limited variety of training data	Most existing machine learning models are based on limited data sets that do not take into account the full variety of possible scenarios and conditions. This results in reduced diagnostic accuracy in cases not represented in the training data, highlighting the need to expand and enrich databases
Insufficient integration of different biometric indicators	Modern research often focuses only on the analysis of the face or voice, leaving out other important biometric indicators such as physiological reactions (heart rate, cortisol levels, etc.). Integration of these additional data could significantly improve diagnostic accuracy and reliability.
Ethical Challenges and Data Privacy	The use of biometric data to diagnose psycho-emotional states raises important issues of confidentiality and protection of personal information. Ensuring data security and maintaining ethical standards is critical to building user trust and widespread adoption of these wellness-engineered technologies.

These gaps include limited diversity of training data, lack of integration of various biometrics, and ethical challenges related to data privacy.

The scientific task is to increase the accuracy and efficiency of assessing the current level of stability and the influence of stress, fatigue and other factors through modern models of machine engineering learning.

METHODOLOGY

The study chose a methodology that combines modern methods of machine learning and engineering analysis with information extreme intelligence (IEI) technology. This is due to the need to increase the accuracy and efficiency of diagnosing a person's emotional and psychological state. Machine engineering learning allows you to create models that can analyze large amounts of data and highlight significant features indicating the level of resilience, the influence of stress, fatigue and other factors. The use of EI technology ensures the effective transformation of information flows, which is critical for the correct assessment of cognitive processes.

Functional analysis was chosen as the main method for constructing categorical models of machine engineering learning. This is due to its ability to clearly define and formalize functional dependencies between different system parameters, which makes it possible to increase diagnostic accuracy. Optimization of the control tolerance system provides additional accuracy and reliability of the models used to analyze the psycho-emotional state of a person. The choice of these methods is due to their effectiveness in solving complex problems of analysis and diagnostics under conditions of uncertainty and abundance of input data.

The research methodology is based on the use of machine engineering learning to create models that can accurately and quickly assess a person's emotional and psychological state. The use of IEI technology allows you to effectively transform information flows and analyze cognitive processes occurring during decision-making.

The initial stage of the study includes the collection of key data, which in our study mainly concerns images of people in various psycho-emotional states. Other files and data containing information about non-verbal emotions will also be auxiliary. During pre-processing, image normalization, image alignment and other actions are carried out to improve the quality of images that will be analyzed further.

The next step was the creation of information models based on IEI technology. These models are designed to analyze and transform information flows, which made it possible to identify essential features necessary to assess the emotional and psychological state of a person. Modern machine learning algorithms were used, including neural networks and deep learning methods, which made it possible to achieve high accuracy of the models. Functional analysis played a key role in the construction of category models. This made it possible to clearly determine the dependencies between various system parameters, which is critical for accurately assessing the psycho-emotional state. Special algorithms automatically determined these dependencies based on training data, which allowed the model to adapt to different conditions and individual characteristics of patients.

Integration of additional sources of information, such as analysis and physiological indicators, was also part of the study methodology. This allowed for increased diagnostic accuracy because the systems could analyze a wide range of nonverbal signals. The interdisciplinary approach provided a comprehensive analysis of the psycho-emotional state of a person.

It should be noted that the use of real data (images of real people who are in one or another psycho-emotional state without coercion) is an important condition for the effectiveness of this methodology. This made it possible to evaluate their effectiveness under different conditions and under different use scenarios. Testing was carried out using various data sets and scenarios, allowing the reliability and accuracy of the models to be verified in real-world conditions. At the final stage of the study, software for a diagnostic decision support system was created. This software ensured the integration of the developed models and algorithms into a single system, which made it possible to automate the diagnostic process and increase its efficiency. The software interface is designed to be easy to use for healthcare professionals.

Thus, the chosen methodology made it possible to achieve high results in increasing the accuracy and efficiency of diagnosing a person's emotional and psychological state. The use of modern machine learning methods, IEI technology and functional analysis ensured the effective transformation of information flows and analysis of cognitive processes occurring during decision-making.

RESULTS OF RESEARCH

Within the framework of IEI technology, engineering-machine learning is carried out by adapting the input mathematical description to the conditions of a specific diagnostic action. This process is based on optimizing the values of genotypic and phenotypic parameters of the system's functioning in order to maximize its information capacity.

The basic functional category of the model of information-extreme engineering-machine learning when determining the emotional and mental state of a person from a facial image can be represented in the form of a set mapping diagram or a directed graph. In this graph, the edges are operators that regulate the display of term sets involved in the engineering machine learning process, as shown in Figure 1.

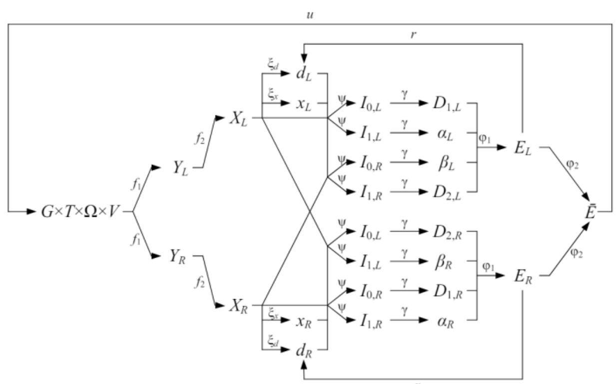

Figure 1. Multiple display diagram according to the main method of IEI technology

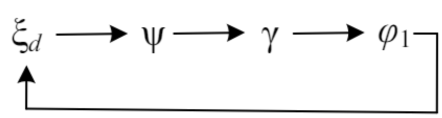

Figure 2. Optimization scheme for determining the optimal radius

By using a multi-cyclic iterative procedure, the optimal radii of separate hyperspherical surfaces for the analysis of left- or right-hemisphere training portraits were determined. A functional category model of machine learning in the field of information extreme engineering is used to determine the emotional and psychological state behind a person's face, taking into account optimal control tolerances for diagnostic signs. This model can be seen in the set mapping diagram in Figure 3.

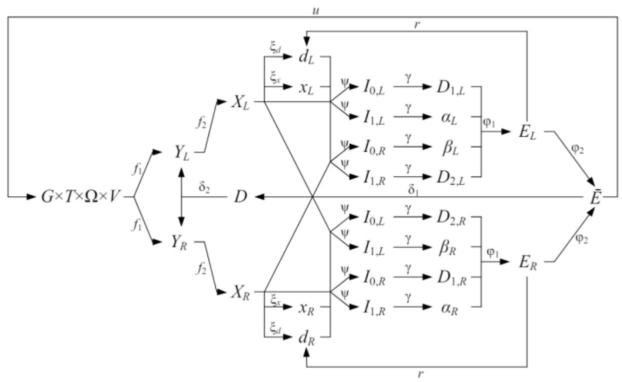

Figure 3. Scheme for displaying sets with optimization of system control tolerances

The difference between the functional categorical model shown in Figure 3 and the basic model (Figure 1) lies in the presence of an additional optimization loop, which is closed through the term set D. Operators 1δ and 2δ modify the system of control tolerances for diagnostic features at each step of the training process, where 1δ initializes the control tolerance array, and 2δ – performs the optimization.

The sequence of operators that regulate the optimization process of the control tolerances system for diagnostic features is shown in Figure 4.

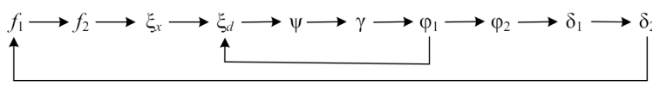

Figure 4. Tolerance optimization scheme for diagnostic features

The additional loop uses an iterative procedure to simultaneously increase the lower and upper control tolerances for a symmetrical two-sided tolerance field or just one of the tolerances for an asymmetrical two-sided field. Since changes in the tolerance system affect the value of diagnostic features in the binary training matrices for both the left and right hemisphere portraits, it is necessary to re-create separate hyperspherical surfaces and optimize their geometric parameters for each case.

Functional category models reflect the transformation of information and information flows that occur during the cognitive processes of formation and adoption of classification decisions characteristic of human perception. Thus, these models can be considered as generalized block diagrams of information-extreme engineering-machine learning algorithms for determining the emotional and psychological state of a person behind a face.

To achieve high efficiency in determining the emotional and psychological state of a person, it is important to evaluate the information content of diagnostic signs that reflect the characteristics of various objects of study, such as the shape and size of the eyes, lips, nose, eyebrows, facial expressions, etc. Assessing the information content of diagnostic signs allows you to determine the most relevant signs for accurately diagnosing a person's emotional and psychological state, which reduces the number of errors when diagnosing the patient's condition. The functional categorical model of information-extreme engineering-machine learning for determining the emotional and psychological state of a face with an assessment of the informativeness of features is presented in the form of a set display diagram in Figure 5.

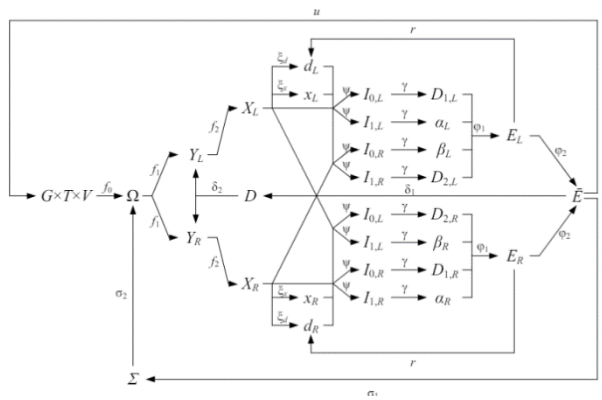

Figure 5. Set display scheme for assessing the information content of features

The difference between the functional categorical model of SPDDR shown in Figure 5 and the basic model lies in the presence of an additional loop that regulates the process of evaluating informativeness, which closes through the term set Σ. The sequence of operators that manage the process of optimizing feature informativeness is shown in Figure 6.

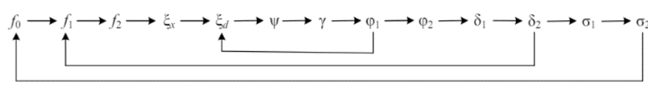

Figure 6. Scheme for assessing the informativeness of features

An additional external contour selects a part of the face in the image and evaluates its information content, comparing the value of the information degree of diversity for the entire portrait and its individual parts in the process of engineering machine learning for diagnosis.

DSSMainComponent serves as a key class in the system, acting as an intermediary between intelligent components and administrative and ontological elements. The main role of DSSMC is to initialize data for system components. It includes several child classes: PatientEMRComponent, NonPatientEMRComponent, PatientStatusComponent, and PsychocorrectionTrajectory, where PatientEMRComponent is responsible for storing basic data and supporting information in the electronic medical record.

The software implementation of the proposed model for assessing the emotional and psychological state of a person was carried out in two versions. The first option is developed in MATLAB using specialized extension packages known as toolboxes, while the second option is based on the use of image processing modules and libraries for vector and matrix calculations. Software in MATLAB allows you to analyze in detail and configure the functional parameters of the developed algorithms to determine the emotional and psychological state, including a set of scripts and scenarios that implement the algorithms described in the previous sections. These features include:

function [Y] = loadY(m,N,n) loads training matrices. The function accepts the following input parameters: m – number of classes for recognition, N – number of features for recognition, n – is the total number of realizations. The function output includes: Y – training matrix.

function [VD,ND] = dopuski(y,delta) creates a system of control tolerances. The function receives the following input parameters: y – training matrix, delta – width of the allowed field. The initial parameters are: VD – upper tolerance, ND – lower tolerance.

function [BM,EV] = bmev(y,vd,nd) plows binary training matrices and sample vectors. Input parameters for this function include y – training matrix, vd, nd – parameters of the control tolerance system. Output parameters: BM – binary matrix, EV – sample vectors.

function [SK] = kodR(ev,bm,kc,k) generates an array of coding distances. The input parameters for this function are kc – the neighbor class number, k – the base class number, bm – binary matrix, ev – reference vectors. Output parameters: SK – array of coding distances.

function [em, delta_opt, d_opt, D1, D2] = oskd(y,vis) determines the left- and right-hemisphere portraits of a person whose emotional and psychological state is being diagnosed.

function [Y] = get_left_rigth_image(image_name, sym_line_param, resize_method). implements an algorithm for creating left- and right-hemisphere portraits of a person based on the frontal image of the face. Input parameters: image name – array of pixel intensities of the frontal facial image; sym_line_param – symmetry line parameter; resize_method – image resizing method. Output parameters: Y - training three-dimensional matrix

function [T] = get_traing_plan(t_beg,t_end,t_step) executes the symmetry line search plan for a facial image. Input parameters. Input parameters: t_beg – start value; t_end – end value; t_step – step size. Output parameters: T – array of potential symmetry lines.

The interface part, implemented for engineering and scientific calculations in the MATLAB environment, is presented in Figure 7 and is intended to reflect the intermediate results of engineering and machine learning.

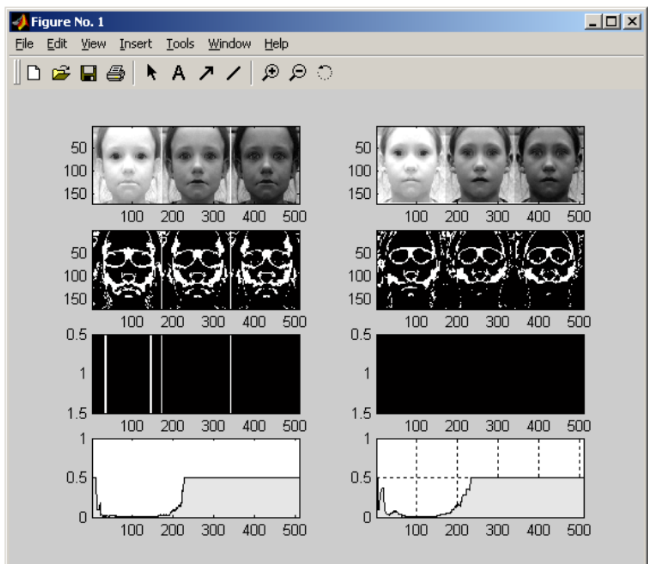

Figure 7. The result of machine learning in graphical form

The web interface is intended for testing, implementing and using the system in clinical settings to diagnose patient conditions. Many functions are implemented based on the open source platform Node.js. A detailed description of the software interface for diagnosing the emotional and psychological state of a face using a photograph of a face has been developed within the framework of the Helsi system.

The first version of the system was developed in MATLAB using specialized extensions called Toolbox. This option uses the versatility and power of MATLAB for data analysis and processing, which is critical for an emotional and psychological state diagnostic system. The second option is based on image processing modules and libraries for vector and matrix calculations, providing flexibility and scalability of development. This approach promotes optimization and acceleration of calculations, which simplifies the development and maintenance of a diagnostic system.

DISCUSSIONS

Analysis and comparison of our findings with the conclusions of other scientific works allow us not only to evaluate the effectiveness of the proposed methods, but to identify the potential advantages and limitations of our approach.

Amin et al. (2023) investigated driver stress detection using multimodal deep learning and fuzzy EDAS approaches. Their work highlights the importance of using different data sources, such as physiological measures and behavioral signals, to accurately detect stress. Our study is different in that it focuses on diagnosing emotional and mental states from facial imaging, which is a less invasive method and can be used in a broader context without the need for specialized equipment.

Graham et al. (2019) provided an overview of the use of artificial intelligence for diagnosing mental health and mental disorders. Their research covers a wide range of methods and technologies used in the field. In contrast to their work, our study focuses on a specific methodology using IEI technology and functional analysis to build machine learning models that improve the accuracy of emotional state diagnosis from facial images.

Ancillon et al. (2022) reviewed the use of machine learning to detect anxiety conditions based on biosignals. Their approach emphasizes the use of physiological data such as heart rate and electrodermal activity. Our study, while recognizing the importance of biosignals, offers a more accessible diagnostic method through facial image analysis that can be easily integrated into everyday devices such as smartphones and webcams. Richter et al. (2020) explored the use of machine learning to distinguish between anxiety and depression based on behavioural data. Their results suggest that behavioural analysis can be effective in identifying specific mental disorders. Our research goes further by using functional analysis to build models that not only distinguish between emotional states, but also assess stress and fatigue levels through the analysis of facial expressions.

Sun et al. (2022) reviewed recent advances in monitoring vital signs in sports and health using flexible wearable sensors. Their research suggests that wearable technology can be effective for long-term physiological monitoring. In contrast to their approach, our research focuses on the use of accessible and inexpensive diagnostic methods, such as facial image analysis, allowing monitoring of psycho-emotional states without the need for specialized sensors.

Al-Atawi et al. (2023) explored stress monitoring using machine learning, Internet of Things (IoT), and wearable sensors. Their work showed that the integration of these technologies can effectively monitor stress levels in real time. Our research is different in that it focuses on analyzing facial images to diagnose emotional states, which is a less invasive and more accessible method that does not require specialized sensors.

Shatte et al. (2019) reviewed methods and applications of machine learning in mental health. Their research covers a wide range of approaches and demonstrates various applications of machine learning for the diagnosis and treatment of mental disorders. In contrast, our study focuses on a specific methodology using IEI technology and functional analysis to improve the accuracy of emotional state diagnosis from facial images.

Giannakakis et al. (2019) developed a stress recognition system based on heart rate variability (HRV) parameters and machine learning methods. Their results indicate high accuracy in determining stress levels using physiological data. Our study, although recognizing the importance of physiological parameters, proposes a diagnostic method through facial image analysis, which is less technically challenging and more user-friendly in different contexts.

Saba et al. (2022) investigated the use of machine learning to identify post-traumatic stress disorder (PTSD) from resting-state functional magnetic resonance imaging (fMRI). Their research shows that machine learning can effectively detect PTSD by analyzing neural activity. Our study is different in that it takes a less invasive approach, analyzing facial images to determine emotional and mental state, which can be done without the use of expensive medical equipment.

Thus, each of these studies makes important contributions to the field of mental health diagnostics using machine learning. Our research proposes an innovative approach that combines IEI technology and functional analysis to create an affordable, accurate, and efficient facial image-based diagnostic system, making it more convenient and accessible for widespread use.

The innovation of this research lies in the introduction of functional category models of information-extreme machine engineering learning, based on IEI technology and optimization of the control tolerance system. The proposed approach can significantly improve the accuracy and efficiency of diagnosing a person's emotional and psychological state by analyzing facial images. The use of modern methods of functional analysis and machine learning ensures the effective transformation of information flows occurring during the cognitive processes of formation and decision-making. The integration of these technologies into a diagnostic decision support system opens up new possibilities for medical diagnosis and monitoring of the psycho-emotional state of patients in real time, which makes this study a significant contribution to the development of this industry.

CONCLUSION

Research aimed at increasing the functional efficiency of a diagnostic decision support system for determining the emotional and mental state of a person using machine engineering learning has demonstrated significant potential in the development of this industry. The proposed models and methods make it possible not only to increase the accuracy of diagnosis, but also to quickly respond to changes in a person's psycho-emotional state, which is extremely important for providing timely medical care. One of the key results of the study was the introduction of categorical models of machine engineering training based on IEI technology. These models demonstrate high efficiency in transforming information flows and accurately reflect the cognitive processes that occur during decision making. By optimizing the control tolerance system, it was possible to achieve a significant increase in diagnostic accuracy, which is an important achievement in this field.

It should be noted that an important and significant aspect of our study is that the methodology we chose is flexible and adaptive in the context of the individual characteristics of the patient. This allows this methodology to be used to analyze a wide range of emotions and conditions (stress, fatigue, and others). In this regard, the results of the study are of exceptional practical importance and can be used in various areas of the healthcare sector. At the same time, the software used allows detailed analyzes to be carried out quickly and without prior preparation. This significantly expands the range of users among medical professionals and improves the quality of diagnostics and medical services.

However, despite significant achievements, there are also some limitations. One of the main challenges is ensuring the quality of the input data since the accuracy of the diagnosis depends on this. It is important when using this methodology to constantly update databases and patient information. These procedures are lengthy, monotonous and require additional time and human resources. But it is the completeness of the data that allows us to achieve the greatest results. At the same time, it should be noted the importance of observing the principles of ethics and confidentiality when using these types of diagnostic methods.

In general, the results of this study indicate the great potential of machine engineering learning in the field of diagnosing the emotional and psychological state of a person. The proposed models and methods have high practical significance and can become the basis for further developments in this area.

Considering that the technologies under study are new and still poorly understood, our study has a number of limitations. First of all, the limitations relate to the dependence of the results obtained and the quality of the analysis on the quality and quantity of images used in the analysis process. In addition, focusing analysis only on the face does not allow the analysis of other nonverbal cues, such as gestures, postures, and unconscious body movements, which can make the analysis more difficult or less accurate.

Taking into account the above limitations, the prospects for further research will be the expansion of the chosen methodology to the analysis of other non-verbal signs. This problem can be solved by including other sources of information (for example, video recordings) in the analysis. This will make the analysis more detailed and complete. Also in the plans for further research will be the integration of other biometric indicators into the system, which will confirm or refute the presence of a particular emotion. This can include indicators such as heart rate, cortisol levels, blood pressure and others. Such integration will increase the level of objectivity of the study.

REFERENCES

Abd-alrazaq, A., Alhuwail, D., Schneider, J. et al. (2022) The performance of artificial intelligence-driven technologies in diagnosing mental disorders: an umbrella review. npj Digit. Med. 5, 87 (2022). https://doi.org/10.1038/s41746-022-00631-8

Al-Atawi, A., Alyahyan, S., Alatawi, M., Sadad, T., Manzoor, T., Farooq-i-Azam, M., Khan, Z. (2023) Stress Monitoring Using Machine Learning, IoT and Wearable Sensors. Sensors, 23, 8875. https://doi.org/10.3390/s23218875

Alharthi, H. (2020). Predicting the level of generalized anxiety disorder of the coronavirus pandemic among college age students using artificial intelligence technology. 2020 19th International Symposium on Distributed Computing and Applications for Business Engineering and Science (DCABES), 218–221. https://doi.org/10.1109/DCABES50732.2020.00064

Amin, M., Ullah, K., Asif, M., Shah, H., Mehmood, A., & Khan, M. A. (2023). Real-World Driver Stress Recognition and Diagnosis Based on Multimodal Deep Learning and Fuzzy EDAS Approaches. Diagnostics (Basel, Switzerland), 13(11), 1897. https://doi.org/10.3390/diagnostics13111897

Anand, R., Md, A, Urooj, S., Mohan, S., Alawad, M. (2023) Enhancing Diagnostic Decision-Making: Ensemble Learning Techniques for Reliable Stress Level Classification. Diagnostics 13, 3455. https://doi.org/10.3390/diagnostics13223455

Ancillon, L., Elgendi, M., Menon, C. (2022) Machine Learning for Anxiety Detection Using Biosignals: A Review. Diagnostics, 12, 1794. https://doi.org/10.3390/diagnostics12081794

Gagnon-Sanschagrin, P., Schein, J., Urganus, A., Serra, E., Liang, Y., Musingarimi, P., Cloutier, M., Guérin, A., & Davis, L. L. (2022). Identifying individuals with undiagnosed post-traumatic stress disorder in a large United States civilian population - a machine learning approach. BMC psychiatry, 22(1), 630. https://doi.org/10.1186/s12888-022-04267-6

Garriga, R., Mas, J., Abraha, S. et al. (2022) Machine learning model to predict mental health crises from electronic health records. Nat Med 28, 1240–1248 https://doi.org/10.1038/s41591-022-01811-5

Gavrilescu, M., & Vizireanu, N. (2019). Predicting Depression, Anxiety, and Stress Levels from Videos Using the Facial Action Coding System. Sensors (Basel, Switzerland), 19(17), 3693. https://doi.org/10.3390/s19173693

Giannakakis, G., Marias, K., & Tsiknakis, M. (2019). A stress recognition system using HRV parameters and machine learning techniques. 2019 8th International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW), 269–272. https://doi.org/10.1109/ACIIW.2019.8925142

Graham, S., Depp, C., Lee, E. E., Nebeker, C., Tu, X., Kim, H.- C., & Jeste, D. V. (2019). Artificial Intelligence for Mental Health and Mental Illnesses: An Overview. Current Psychiatry Reports, 21(11), 116. https://doi.org/10.1007/s11920-019-1094-0

Li, Y., Li, N., Zhang, L., Liu, Y., Zhang, T., Li, D., Bai, D., Liu, X., & Li, L. (2022). Predicting PTSD symptoms in firefighters using a fear-potentiated startle paradigm and machine learning. Journal of affective disorders, 319, 294–299. https://doi.org/10.1016/j.jad.2022.09.094