ПРИЛОЖЕНИЕ 4

1. Резюмета на английски език на научните публикации представени за участие в конкурс за АД „Професор“

1.1 Резюмета за публикациите от група „В.4“

[B4.1] V. Markova, T. Ganchev, K. Kalinkov, M. Markov," Detection of acute stress caused by cognitive tasks based on physiological signals", Bulletin of Electrical Engineering and informatics, 2021, vol.10, n.5, SJR 0.251 2020

We report on the development of an automated detector of acute stress based on physiological signals. Our detector discriminates between high and low levels of acute stress accumulated by students when performing cognitive tasks on a computer. The proposed detector builds on well-known physiological signal processing principles combined with the state-of-art support vector machine (SVM) classifier. The novelty aspects here come from the design and implementation of the signal pre-processing and the feature extraction stages, which were purposely designed and fine-tuned for the specific needs of acute stress detection and from applying existing algorithms to a new problem. The proposed acute stress detector was evaluated in person-specific and person-independent experimental setups using the publicly available CLAS dataset. Each setup involved three cognitive tasks with a dissimilar crux of the matter and different complexity. The experimental results indicated a very high detection accuracy when discriminating between acute stress conditions due to significant cognitive load and conditions elicited by two typical emotion elicitation tasks. Such a functionality would also contribute towards obtaining a multi-faceted analysis on the dependence of work efficiency from personal treats, cognitive load and acute stress level.

Experimental results confirm that we can distinguish between low and high levels of acute stress caused by cognitive activities. The experimental evaluation at both person-specific and non-person settings confirmed the practical applicability of the proposed method for detection in an experimental situation, which is close to a personalized learning environment. Using the proposed methodology, an accuracy of acute stress recognition of 99.72% is achieved in models specific to the individual and 99.68% in the development of models independent of the individual. The results show the possibility of developing systems with acute stress recognition functionality, which functionality would facilitate the development of adaptive e-learning environments that use continuous real-time monitoring of acute stress levels. Assessing the level of acute stress would allow adaptability of the intensity of the learning process, so that the system can manage situations with high levels of cognitive load, leading to reduced ability to absorb. In addition, the availability of such adaptability would allow the learner to remain in an area of high concentration and high motivation for a longer period, which would improve productivity and the quality of training.

[B4.2] V. Markova, T. Ganchev, M. Markov, "Automated Annotation of Valence and Arousal during Cognitive Activity", BIOMESIP 2021, 19-21 July, Lecture Notes in Computer Science (LNCS), 2021

We present an automated annotation method, which infers emotional arousal and valence tags based on physiological signals. This is performed with the help of binary detectors trained to recognize high/low arousal or passive/negative valence. The arousal and valence detectors were created from representative datasets containing evoked emotional reactions to widely used audio-visual stimuli. Next, these detectors were used to annotate physiological signals collected during different types of cognitive activity in the context of acute stress scenarios.

We show that the automatically generated tags are correlated with work efficiency during various cognitive activities. The availability of such an automated annotation method would facilitate future studies on the influence of individual differences concerning work performance and the ability to cope with acute stress and cognitive overload. Such a functionality would also contribute towards obtaining a multi-faceted analysis on the dependence of work efficiency from personal treats and emotions.

In the present study, we investigate the applicability of an automated annotation process that helps mark portions of physiological signals captured during high / low arousal cognitive activities and negative / positive valence labels. Models of arousal and valence were developed using recordings of physiological signals captured during stimulation with photographs and music videos aimed at eliciting specific emotion excitatory and valence reactions of varying intensity. We show that automatically generated labels are related to the effectiveness of work during various cognitive activities.

[B4.3] V. Markova, T. Ganchev, E. Pencheva, I. Atanasov, “Intelligent architecture for real-time personal health monitoring in the context of 3G/4G/5G networks”, 29th National Conference with International Participation (TELECOM), 28-29Oct. 2021

As a result of research and development of the research team related to personalized real-time health monitoring, a new intelligent architecture for highly responsible communications has been synthesized, which is sensitive and adaptable to the context of existing 3G / 4G / 5G networks. The analysis of the potential and the provided functionalities confirms that the use of this new smart architecture could create concrete new opportunities for integrating programmability and intelligence in systems that rely on highly responsible communications through cloud computing at the end of the mobile network.

The following sections discuss some of the main communication aspects and the different modes of operation that the new adaptive architecture can implement in the implementation of the principles and characteristics associated with continuous monitoring of physiological and behavioral parameters in real time. Specifically, the proposed intelligent architecture for real-time physical and mental health monitoring is built through the integration of the following main components:

(i) *intelligent sensing devices* capable of recording, distinguishing and interpreting basic physical parameters consisting of awareness and recognition of basic behavioral parameters,

(ii) *personal mobile devices* (tablets, telephones, laptops, laptops, etc.) that serve as special data hubs, information gateways and displays, and

(iii) *server resources* for remote storage and processing, where data are aggregated and used for further long-term trend research and statistical modeling.

More importantly, however, it is capable to sense the communication context and providing a seamless transition between environments with dissimilar communication capacities and allowing for graceful degradation of functionality in case of a shortage of battery or local storage resources. The last is expected to provide numerous benefits that are expected to facilitate the pervasiveness of eHealth monitoring solutions.

[B4.4] K. Kalinkov, **V. Markova**, T. Ganchev, “The Effect of Acute Stress on the Performance of Students in Engineering Education”, Proc. of 56th Internationl Scientific Conference on Information, Communication and Energy Systems and Technologies (ICEST), 16-18June, Sozopol, Bulgaria, 2021

In the presents paper, we summarize the results of a recent study on the relationship between task-caused acute stress and students' performance. Our experimental protocol was based on the CLAS dataset, which contains physiological signals of 60 students. The physiological recordings were captured during students' involvement in five different tasks, including three interactive tasks (Stroop test, Math test, IQ test) and two non- interactive tasks. The non-interactive tasks aimed at emotion elicitation via blocks of sixteen photographs and sixteen emotional music video clips, purposely selected to cover the entire arousal-valence space. We observed that the three Stroop, Math and IQ tests cause higher acute stress levels than pictures and musical stimuli purposely selected to provoke emotional reactions. The experimental results show that acute stress has different effects on students' academic performance, depending on their gender and individually. Specifically, in contrast to the females, males were observed to show lower stress levels in the Math test. At the same time, males were observed to be less concentrated on the Stoop test. We observed that heart-rate variability (HRV) could be used as an indicator of the students' performance under stress as it is not related to students' abilities.

[B4.5] K. Kalinkov, **V. Markova**, T. Ganchev, "Front-end Processing of Physiological Signals for the Automated Detection of High-arousal Negative Valence Conditions", Proc. of 10th National Conference with International Participation, ELECTRONICA 2019, 16-17May 2019, pp.1-4, Sofia, Bulgaria. doi: 10.1109/ELECTRONICA.2019.8825647.

We propose a new scheme for front-end processing of physiological signals which is designed for the needs of automated detection of high-arousal negative valence conditions. The front-end incorporates three stages: signal pre-processing of ECG and EDA signals, feature extraction, and post-processing of feature vectors. Different configurations of the front-end were evaluated for the automated detection of high-arousal negative valence conditions. The evaluation setup implements a common experimental protocol, which makes use of the MAHNOB-HCI dataset. The experimental results prove that the post-processing with scaling of all features to the dynamic range [0, 1] is advantageous to other post-processing schemes and the raw features.

In a common setup, we evaluated three dynamic range equalization methods applied on the signal features. The experimental results show that scaling of features to the range [0, 1], followed by Fishers Discriminant Analysis with threshold 2, improves the detection accuracy from 66.3 % to 83.3 %. This opens up an interesting research opportunity to evaluate which features are more frequently selected among different users and perhaps derive some ranking of their discriminative power.

[B4.6] V. Markova, K. Kalinkov, T. Ganchev, "Improved Peak Detection Algorithm for Photoplethysmographic Signals," 28th National Conference with International Participation (TELECOM), 2020, pp. 10-13

We present a computationally efficient non-parametric algorithm for the automated detection of systolic peaks in photoplethysmography (PPG) signal that does not require preprocessing for artifact elimination, signal filtering, or detrending. It is validated in an experimental setup based on the publicly available CLAS dataset. The experimental results show that it outperforms two well-known methods in terms of detection accuracy and computational demands. We report a very high detection accuracy, with an error rate below 0.5%, on good quality signals and below 13% on very low-quality PPG signals. The proposed algorithm is characterized with very short processing times and on a low-cost laptop computer requires approximately 0.000012 real-time for the processing of a60-seconds recording.

Furthermore, the algorithm proposed here makes use of a procedure for detection of peak candidates that are suspected as being wrongly positioned, and only for these implements additional two-step procedure for fine-tuning of their position. This brings numerous advantages in terms of noise robustness and accuracy of peak detection. In summary, the main advantage of the proposed algorithm is that it does not require detrending, filtering, or artifact removal, which makes it computationally efficient and easy to implement on various mobile platforms. The algorithm is free of complex adjustments and fine-tuning. It has been demonstrated experimentally that the proposed algorithm provides fast and accurate detection of systolic peaks in photoplethysmographic signals and copes well with problematic and low-quality PPG signals.

The availability of an accurate PPG peak detection algorithm, which does not require computationally extensive preprocessing steps, such as detrending, elimination of artifacts, and filtering, makes the proposed algorithm very appealing for incorporation in methods for monitoring of emotions, cognitive activity, concentration etc., required for the development of adaptive HMI interfaces. The low computational demands open additional opportunities for lowering the resources required for the automated monitoring of the physiological parameters of the human body.

[B4.7] E. Pencheva, **V. Markova**, I. Atanasov, T. Ganchev, "An Approach to Improve Reliability of Vital Signs Monitoring," 2019 International Conference on Biomedical Innovations and Applications (BIA), 2019, pp. 1-4, doi: 10.1109/BIA48344.2019.8967467.

In many life situations, the reliable transmission of patient health data is an important and critical issue. The multi-connectivity feature of fifth generation (5G) mobile systems is a way to improve reliability, as it enables multiple simultaneous radio links from source to destination. The open access to this Radio Access Network functionality enables external application to manage the connectivity of user devices based on user location, information about radio conditions and level of cell congestion.

Multi-connectivity for different air interface variants or radio access technologies provides simultaneous multiple radio links from source to destination and thus enables to achieve high reliability and high data rates for mMTC and URLLC. By opening the access to multi-connectivity functionality in RAN it is possible to delegate the responsibility of managing secondary node connectivity to external analytic applications. These analytic applications may initiate adding, modification or release of additional radio links based on the user location, information about radio conditions and the level of congestion in RAN etc. The reliable data transmission is extremely important for e-Health applications where safety, timeliness and dependability are vital attributes.

In this paper, we propose an approach to improve throughput and reliability of data transmission by using Multi-access Edge Computing. We propose a new service which enables mobile edge applications to add, modify or release secondary radio access nodes, as well as to be notifies about multi-connectivity related events in the network. The service functionality is described by typical use cases, the respective data model and interface definition. The approach feasibility is illustrated by modeling the behavior of the mobile edge applications and RAN in management of multi-connectivity.

The reliability is an important and critical issue in remote healthcare monitoring where data have to be delivered in near to real time and in secured way.

[B4.8] K. Kalinkov, T. Ganchev, **V. Markova**, "Adaptive Feature Selection through Fisher Discriminant Ratio," 2019 International Conference on Biomedical Innovations and Applications (BIA), 2019, pp. 1-4, doi: 10.1109/BIA48344.2019.8967450.

We present an adaptive feature selection method that makes use of Fisher's discriminant ratio (FDR) with flexible threshold which is adjusted in a person-specific manner. The proposed method is shown to improve the detection of high-arousal negative-valence (HANV) conditions, based on two combinations of physiological signals (ECG+GSR and PPG+GSR). We validate the proposed method in an experimental setup aiming at the automated detection of HANV conditions evoked by audio-visual stimuli and picture stimuli. The experimental results support that the proposed method yields to an improvement of the classification accuracy of an SVM-based detector on average with 5.6%±0.6% in comparison with the traditional non-adaptive FDR-based feature selection using threshold 0.3, and with the full set of 39 features.

[B4.9] I. Balabanova, S. Kostadinova, **V. Markova** and G. Georgiev, "Speech Stress Recognition by Sound Analysis and Multilayer Artificial Neural Networks," 2020 International Conference on Biomedical Innovations and Applications (BIA), 2020, pp. 77-80, doi: 10.1109/BIA50171.2020.9244508.

The report presents the study of recognition of stress states through Multilayer Backpropagation Neural Networks (MBNN) based on extracted sound indicators at speech signal analysis. Experimental neural architectures with tangent-sigmoid and logarithmic-sigmoid functions in the two hidden layers with different initial activation were tested. The models with initial logarithmic-sigmoid type, where the obtained maximum accuracy is 75.00%, are defined as inapplicable. In MBNNs with linear and tangential-sigmoidal functions in the initial layers, significantly better adequacy was found as the highest levels of the indicator reached 100.00%.

[B4.10] K. Kalinkov, **V. Markova** and T. Ganchev, "Heart Rate Variability calculation methods," 2020 International Conference on Biomedical Innovations and Applications (BIA), 2020, pp. 97-100, doi: 10.1109/BIA50171.2020.9244285.

We present a gathering of information what is heart rate variability, it's uses and interpretation. We also make an overview of the methods in time and frequency domain and also the nonlinear method for calculation of heart rate variability. The experiments compare different implementations of those methods in separate platforms – Matlab and the widely used, among medical experts and specialist, software platform Kubios. The results in the time domain prove to be almost identical, the frequency domain show similar trends even if the absolute values are not identical, and the results in the nonlinear calculations are similar.

The results show that both platforms used for the calculation of parameters relevant to the Heart Rate Variability are very similar. The differences are due to slightly different lengths of signals and IBI intervals and to the differentiation of the approach of calculation (Calculations based on the IBI and NN intervals). The results show that the Matlab calculations are very consistent and that Kubios is prone to calculate outliers in the parameters when used with low artifact corrections. The stronger corrections in Kubios improve the performance, but in some cases cause strong distortions in the loaded inter beat intervals. The HRV calculation in the frequency domain shows similar trends through Welch method calculation of LF/HF ratio in both Matlab and Kubios, as the FFT shows very weak similarity to the others. The SD1 and SD2 parameters from the non-linear approach show differences based on the methodology of calculation and the artifact correction from Kubios.

1.2 Резюмета за публикациите от група „Г.7“

[Г7.1] I. Balabanova, S. Kostadinova, **V. Markova**, S. Sadinov, G. Georgiev. “Voice control and management in smart home system by artificial intelligence*”. IOP Conference Series: Materials Science and Engineering*, vol.1032(1), 2021. doi:10.1088/1757-899X/1032/1/012007. SJR 2019 0.198, SNIP 2020 0.484

The paper provides a 3D architectural model of Smart Home system. An information data sets of parameters in sound analysis of test voice commands were collected. The following analyzed indicators are included, respectively LZE, LZeq, LZF, LZS, LZI, LAE, LAeq, LAF, LAS, LAI, LCE, LCeq, LCF, LCS, LCI and LEX8h. Backpropagation and Hybrid algorithms based Artificial intelligence (AI) and Adaptive neuro-fuzzy interface system (ANFIS) were synthesized. Selected architectures are integrated in intelligent automated voice control system for human access control, power switching and lighting, air conditioning systems and home appliances. In the process of synthesis, different criteria for network performance in the analysis of activation type in the output layers in AI and input layer in ANFIS are applied. About all considered voice categories for functional control an accuracy of 100.0% was established. Verification procedures concerning reliability of the achieved results were performed for correct confirmation.

Artificial intelligence is finding more and more applications not only in industry, but also in terms of increasing the comfort of people's lives in the construction of new modern type of housing. The presented research demonstrates the strength of its computational advantages, as well as the possibility of combining with the mathematical apparatus of fuzzy logic in the development of voice control systems with the potential for implementation in homes, offices and buildings.

[Г7.2] I. Balabanova, S. Kostadinova, **V. Markova**, S. Sadinov, G. Georgiev." Statistical techniques to determine of optimal and acceptable noise levels". *the IOP Conference Series: Materials Science and Engineering",* 1032(1), 2021. doi:10.1088/1757-899X/1032/1/012006. SJR 2019 0.198, SNIP 2020 0.484

The paper presents an approach for an application of QoS procedures, on noise impacts in communications, respectively Uniform White Noise (UWN), Gaussian White Noise (GWN), Bernoulli Noise (BN) and Poisson Noise (PN). The approach consists in experimental establishment of recommended optimal and acceptable limit levels of the noise indicator Root Mean Square based (RMS) on the processing of registered information sets for each specific noise. A set of methodological statistical procedures are applied to the experimental data with respect to the complete and individual input sets (RMS levels for each individual noise). Types of family characteristics are analyzed and evaluated about different quality indicators as "Mean Plot of multiple variables", "Normal Probability Plots", "Individual Plots", "X-Bar and R char variable", "Capability Plots" and "Capability Histograms". The approach is also associated with the detection of RMS samples with deviations outside the defined statistical levels, as well as their exclusion in order to improve the quality of the processed information sample.

Based on the processing and analysis of the experimental data, capability indicators are obtained. The Cr indicator can be accepted with the highest degree of significance, according to which the group "RMS at BN" is determined with the best quality, followed by "RMS at PN", "RMS at UWN" and "RMS at GWN".

The proposed methodology can be successfully applied to statistical analyzes of different types of information arrays related to interfering effects on electrical signals, input and output traffic flows in communication systems.

[Г7.3] N. Grozev, **V. Markova**, "Tropospheric Trapping Refractive Conditions over Black Sea and its Impact over Radio Wave Propagation," *2020 11th IEEE Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON)*, 2020, pp. 0635-0640, doi: 10.1109/IEMCON51383.2020.9284905.

A better understanding of radio wave propagation under ducting condition could improve the maritime (naval and civil) and coastal communications. For that purpose, a detailed survey of the state of the atmosphere is carried out on two settlements located on the Black Sea. At the same time, the electromagnetic field strength is measured for three different radio frequencies propagated between them. The results showed more than one tropospheric ducts simultaneously at any different points and different effects over different radio frequencies. A clear relationship between absolute value of modified refractivity and the levels of received signals for the surveyed regions is observed.

A detailed study of the state of the atmosphere and in particular of the refractive index and the modified refractive index over two regions over the Black Sea is presented in parallel with measurements of radio frequency propagations for three different frequencies between them. The following conclusions can be drawn:

- The propagation of radio signals depends on the state of the atmosphere over the two regions;
- Higher EMF levels are due to more than one trapping refractive conditions simultaneously. To determine the type and strength of these conditions, it is necessary to study the atmosphere at a higher altitude and for a longer period;
- Incompatible to some statements in the literature such as (9), there is a clear relationship between absolute value of modified refractivity and the levels of received signals for the observed regions;
- The formation and change of the parameters in the elevated duct with size up to approximately 50 m height has a great influence on the higher frequencies and insignificantly for 98.4 MHz.

A lot of efforts are still to be made in order to improve the propagation models. It's obvious that the good knowledge of propagation under ducting could improve the maritime (naval and civil) and coastal communications.

[Г7.4] S. Vachinska, **V. Markova**, T. Ganchev "A risk assessment study on musculoskeletal disorders in computer users based on a modified Nordic Musculoskeletal Questionnaire*", International conference BioInfoMed'2020*, 8-10 Oct.2020, Burgas, Bulgaria. *Accepted for* p*ublication at the book series "Studies in Computational Intelligence".*

We present a recent study on musculoskeletal disorders (MSDs) risk assessment in computer users. For this study, we collected data from 60 people who usually use PCs in their work routine. The data collection campaign was implemented using a modified Nordic Musculoskeletal Questionnaire (NMQ). Based on the post-test briefings with the participants, we found out that the questionnaire brought an educational benefit because it made the participants aware of specific inappropriate habits and body postures. Specifically, the test provoked the participants to think about the trunk's proper posture, upper and lower limbs, the distance to the screen, the position with respect to the keyboard, mouse, etc., which was perceived as beneficial and useful. Thought-provoking outcomes of our study are the conclusions that there is an urgent need for proper training of the average computer user on the health compliant work positions and healthy habits. Furthermore, energetic efforts are required to popularize good practices for the safe use of computers and related standards. The results obtained to this end motivate the development and promotion of adequate proactive measures for computer users' long-term health preservation. The findings reported in the current study are essential for people who use computers daily, as they are exposed to MSDs-related risks.

The results of our study confirm that pains in muscles and knuckles are connected with bad body posture, prolonged sitting, and non-ergonomic setup of the working place. The workers with long years of service suffer more frequently than young employees. Seated computer work results in prolonged static loading associated with the development of MSDs confirmed throughout the current study by the reported pain discomfort and non-ergonomic postures.

The simplest solution against MSDs is to train workers to safely perform their work without making it cumbersome or compromising precision and effectiveness. Based on this analysis, we determined an action plan to reduce the pain reported by computer users. The general risk assessment procedure for MSD prevention is similar to other workplace hazards and have four steps:

S1 - Recognize and identify an MSD hazard (checklist questionnaire, workers conversation, observation, etc.);

S2 - Assess its risk to workers and try to eliminate the hazard (teach worker, change workplace hazard and organization to be safe for people);

S3 - Controls the risk of workers - put in place to reduce it (engineering and administrative control, periodical risk assessment);

S4 - Evaluate the effectiveness of the control (improve worker's health and work productivity).

Finally, we need to point out that the establishment of habits for proper and safe sitting and using a computer or laptop is recommended to start at school age because since then the initial skills to maintain a neutral posture are formed and since then start the first symptoms of health problems.

[Γ7.5] V. Markova, T. Ganchev "Technological support to musculoskeletal disorders assessment and management", *International conference BioInfoMed'2020,* 8-10 Oct.2020Burgas, Bulgaria. Accepted for publication at the book series *"Studies in Computational Intelligence*".

Work efficiency and quality of life largely depend on health. Daily computer use is an integral part of work, educational activities, and entertainment, and as it is already well known, it increases the risk of developing various musculoskeletal disorders (MSDs). MSDs are the main reason for chronic body pain, most often in the upper limbs, shoulders, or neck. In this regard, we present the ERGO-project's overall concept, which aims to develop appropriate resources and advanced technological tools supporting the early diagnosis and management of MSD among computer users who use PCs in their work routine. Our concept is based on the assumption that contemporary technology can support the standard therapeutic procedures used by medical staff to identify MSDs and the periodic assessment of MSDs progress. Specifically, we aim to develop a technological platform and appropriate tools for the automated estimation of the current body position based on video or images, questionnaire-based distress assessment, and concentration assessment based on physiological signals. Our project's main objectives are to develop a set of indicators and mobile apps that help manage MSDs in work-related computer use. The project also has educational aspects as we aim to make computer users aware of the good practices and the relevant regulations for long-term preservation of health and work efficiency.

The ERGO-project developed a modular technological platform, resources, and tools to implement this methodology. The proposed management methodology can help monitor MSDs-related indicators, and subsequently, cope with work-related stress, improve body posture, and enhance the ergonomic work environment. Summarizing the results of this study, we provide technical support to the long-term efforts to prevent, monitor, and manage MSDs, improving work-efficiency, preserving health, and enhancing the overall quality of life.

[Γ7.6] M. Ivanov, **V. Markova** and T. Ganchev, "An Overview of Network Architectures and Technology for Wearable Sensor-based Health Monitoring Systems," *2020 International Conference on Biomedical Innovations and Applications (BIA), 2020,* pp. 81-84, doi: 10.1109/BIA50171.2020.9244286

As the population ageing is one of the most significant trends of the 21st century, the traditional methods for monitoring and diagnosis of elderly people are no longer sufficient for providing them with a satisfactory quality of life. One of the promising approaches that helps towards addressing such challenges is the employment of communication and information-based systems, allowing automated remote health monitoring and data analysis. The evolutionary transition to digital healthcare requires the definition of new concepts, architectural models and functionalities, subject of study by the scientific community and technology standardization bodies. In the present paper, we overview a wide range of architectures and technological solutions that were recently proposed for the needs of health monitoring, with focus on systems that are based on communication connectivity. We provide a comprehensive analysis and some critical comments on the potential technological shortcomings and challenges of these solutions.

Ubiquitous communication connectivity and high-speed data exchange create prerequisites for the implementation of advanced health monitoring systems aimed at improving the quality of life. Despite the remarkable potential of their functionalities, the innovative nature of this field introduces challenges toward the integration of state-of-the-art network technologies to support real-time remote monitoring and diagnosis of diseases. One of the important issues is the need for in-depth evaluations on network performance and scalability, which will enable development of more advanced communication frameworks for seamless integration of a wide range of critical medical applications.

[Γ7.7] F. Feradov, T. Ganchev and **V. Markova**, "Automated Detection of Cognitive Load from Peripheral Physiological Signals based on Hjorth's Parameters," *2020 International Conference on Biomedical Innovations and Applications (BIA)*, 2020, pp. 85-88, doi: 10.1109/BIA50171.2020.9244287.

The prolonged exposure to high levels of cognitive effort causes fatigue and stress-related decrease of attention and concentration, which are known to compromise work efficiency, safety, and health. In the present study, we investigate the applicability of the Hjorth parameters, namely Activity, Mobility, and Complexity, computed from peripheral physiological signals, as features on the automated cognitive load detection task. Specifically, here we consider the detection of high cognitive load in a person-independent scenario based on galvanic skin response (GSR) and photoplethysmographic (PPG) signals.

In the presented paper we evaluated the performance of Hjorth's parameters (ACTIVITY, MOBILITY, and COMPLEXITY) for cognitive load detection from peripheral physiological signals, namely PPG and GSR recordings. To assess the practical worth of Hjorth's parameters, we carried out a comparative evaluation in a common experimental protocol based on a subset of the CLAS dataset, which contains GSR and PPG recordings of 60 people while they were engaged in problem-solving tasks, such as Math- task and IQ-task. An experimental evaluation of the individual performance and the combination of the studied features was conducted using data evaluated using data extracted from participants performing tasks related to cognitive loads, such as solving Math and IQ tasks. The discriminative capability of the Hjorth parameters was evaluated with four classification methods when Activity, Mobility, and Complexity are used individually and in combination. We report detection accuracy of up to 84.7% and 80.5% on the Math-task and IQ-task, respectively.

Based on the experimental results, it can be concluded that Hjorth's parameters, computed for segments of PPG and GSR signals are applicable for the automated detection of states with increased cognitive load.

[Г7.8] I. Balabanova, **V. Markova**, S. Kostadinova and G. I. Georgiev, "Comparative Analysis between Machine Learning Methods in Tones Classification," *2020 28th National Conference with International Participation (TELECOM)*, 2020, pp. 45-48, doi: 10.1109/TELECOM50385.2020.9299535.

This paper presents the comparative analysis between the indicators in synthesis of models based on machine learning techniques for RMS noise levels recognition about tones with frequencies 75 Hz, 100 Hz, 125 Hz, 150 Hz, 175 Hz and 200 Hz. Linear, diagonal-linear, pseudo-linear, quadratic, diagonal-quadratic and pseudo-quadratic discriminant classification models were performed in MATLAB. A pseudo-quadratic model with the highest accuracy of 84.650% was selected. Based on the Naïve Bayes algorithm with Gaussian and Kernel probability distributions of the input variables is implemented in the classification process as the better results is reported in the second approach. In selection of the metric distance, respectively Euclidean, Cityblock, Minkowski and Chebychev by the k-NN method, an accuracy range from 89.800% at Cityblock to 91.050% at Euclidean at the experimentally established best value of k=3 is observed. Optimal and basic models for chosen of the solution from many of possibilities at tone recognition were synthesized.

The uses of machine learning methods show good potential applicability in the identification of experimental signals. According to the results presented in the process of research, the selected classifiers using the k-NN and Decision tree methods are characterized by the highest efficiency. The choice of optimal structure for the model in the second method depend on the requirements in terms of occupied resource memory, computing power and time for a particular application, etc.

[Г7.9] I. Balabanova, S. Kostadinova, **V. Markova** and G. I. Georgiev, "Identification of Tones with Noises by Artificial Intelligence," *2020 28th National Conference with International Participation (TELECOM)*, 2020, pp. 41-44, doi: 10.1109/TELECOM50385.2020.9299531.

The paper presents the results of the application of the apparatus of artificial backpropagation neural networks in identification of signal frequency tones with different RMS noise level. The Levenberg-Marquardt (LM) and Scaled Conjugate Gradient (SCG) training algorithms were applied in the processes of neural synthesis. The results cover groups of indicators such as Mean Squared Error (MSE), Cross- Entropy (CE), Correlation coefficients and Classification Accuracy in train, validation and test procedures. Three- layer with 35 hidden neurons and four-layer architectures with 22 in the first and 11 neurons in the second hidden layer in hyperbolic tangent transfer functions with maximum accuracy of 96.00% and 98.00% in LM training were selected. About the procedures for SCG algorithm with softmax output activation function a neural network with the best accuracy of 94.3% in 29 hidden neurons was synthesized.

Achieved positive results give grounds to continue the research in the direction of a larger number of analyzed signals with extension of the frequency range and increase the identification RMS tone groups. The neural models can be successfully implemented on practical applications in the communication systems in transmitting data about signal processing and analysis.

[Г7.10]I. Balabanova, S. Kostadinova, **V. Markova** and G. Georgiev, "Synthesis of Prediction Models for Levels of Noises in Electrical Signals," *2020 International Conference on Biomedical Innovations and Applications (BIA), 2020*, pp. 149-152, doi: 10.1109/BIA50171.2020.9244489.

The results of evaluation of linear regression models and artificial neural networks (ANN) with linear output activation for prediction of the amplitude of Uniform White Noise superimposed in signals with Sine, Square, Triangle and Sawtooth shape are presented in the paper. Regarding the models, various statistical parameters were derived for the signals used as independent predictive variables. In the course of the research different variations of the coefficients of certainty in the regression analysis and the correlation coefficients in ANN were registered and the indicators “maximum” and “minimum” values were selected according to their highest levels. Predictive mathematical regression models of zero degree are derived for the considered signal groups with R2 above "0.99", determining the application of higher degree models as unnecessary and inappropriate. A selection of neural architectures was made according to the requirement for minimum of the Mean Squared Error indicator (MSE), reported at 14, 15, 9 and 11 neurons in the intermediate layers in the sequence of the listed.
Regression and neural models for analysis of transmitted electrical signals with added Constant white noise, with good quality indicators were obtained. The approach proposed in the report could be potentially aimed at studying other types of noise and types of signals in various fields of technology to assist the work of application developers and analyzers.

[Γ7.11] V. Markova, T. Ganchev, “Technological support for the needs of personalized training”, *2019 29th Annual Conference of the European Association for Education in Electrical and Information Engineering (EAEEIE)*, 2019, pp. 1-4, doi: 10.1109/EAEEIE46886.2019.9000468.

We present the conceptual design of an e-Learning framework that makes use of an advanced technology in support of the personalized training of young people. This concept builds on the integration of novel functionality that implements an automated objective evaluation of the cognitive effort, the degree of attention and concentration, the emotional condition, and the stress level of a trainee, based on physiological signal processing. Such an awareness helps for the automated adaptation of the training process to the personality traits and to the momentary capacity of each trainee. Such a novel technology allows the development of intelligent training applications that adapt to the momentary capacity of the trainee to comprehend and advance with the current tasks and help towards the optimization of the learning outcome. Such a concept also offers new opportunities for the development of more engaging and more efficient training process and the design of an universally accessible interfaces.

[Г7.12] I. Balabanova, S. Kostadinova, **V. Markova** and G. Georgiev, "Analysis and Categorization of Traffic Streams by Artificial Intelligence," *2019 International Conference on Biomedical Innovations and Applications (BIA), 2019*, pp. 1-5, doi: 10.1109/BIA48344.2019.8967475.

This report presents an evaluation of artificial neural networks in terms of computational efficiency, by analyzing transmitted information flows for determination the type of defined traffic categories using artificial intelligence. The subject of study are Markov M/M/c circuits with unlimited number of waiting calls in the queue and fixed number of server stations in accordance with the desired test categories, as follows c=5, c=10 and c=15. Three layer architectures are applied to different types of neural output activators with Levenberg-Marquardt training, respectively linear, tangent-sigmoidal and logarithmic-sigmoidal. The lowest values of the Mean Squared Error (MSE) of 0.0080, 0.0041, and 0.1923 are experimentally established at 7, 3, and 25 hidden neurons for the indicated activation functions. An accuracy levels of 94.4%, 100.0%, and 70.6% were obtained against indicator levels for identical numbers of neurons.

Generally, a neural model with a given logarithmic sigmoidal function is determined to be inappropriate for the purpose of the study. Selected neural architectures for linear and tangent-sigmoidal activation types can be applied at almost the same predicted accuracy, but keeping in mind the received double less mean squared error of tansig type, this model can be considered as the most appropriate for the task of the study. The introduction of smart categorization enables system administrators to determine quickly and efficiently the type of traffic data processed at any given time. This will expand the range of functional aspects of the QoS service in transmitting and analyzing different volumes and types of information arrays.

[Г7.13] I. Balabanova, S. Kostadinova, **V. Markova** and G. Georgiev, "Categorization of Markov Chains M/ M /c/k by Feed-forward Neural Networks," *2019 International Conference on Biomedical Innovations and Applications (BIA)*, 2019, pp. 1-5, doi: 10.1109/BIA48344.2019.8967461.

The report presents the study of the possibility of applying Artificial Intelligence to analyze traffic data in order to define their category against the observed circuits for different number of server stations in M/M/c/k queuing model, respectively c= 0, c= 5 and c=20. Feed-forward neural models with Scaled Conjugate Gradient training are used at given "sigmoid" activation types in hidden and "softmax" in output network layers. The selection is performed in range of 3 to 25 intermediate neurons in assessing the information content of five input indicators - "client ID", "service request time", "service starting time", "server id" and "release time of requests". A model is synthesized for four input variables without the "service request time" parameter and accuracy of 87.7% was achieved. For the established model, the experiment was extended to 39 neural units, to reaching a potential accuracy level of over 90.0%. The highest accuracy of 90.7% is achieved at 33 neurons.

The study demonstrates the possibility of applying artificial intelligence in the categorization of Markov chains based on the analysis of traffic data on received client requests. The aforementioned approach for the evaluation and synthesis of neural structures with SCG training can be successfully modified and implemented in large information systems serving different industries, regardless of the type of transmitted information arrays.

[Γ7.14] V. Markova, T. Ganchev and K. Kalinkov, "CLAS: A Database for Cognitive Load, Affect and Stress Recognition," *2019 International Conference on Biomedical Innovations and Applications (BIA)*, 2019, pp. 1-4, doi: 10.1109/BIA48344.2019.8967457

We present the overall design and the implementation of the CLAS dataset, a multimodal resource which was purposely developed in support of research and technology development (RTD) activities oriented towards the automated recognition of some specific states of mind. Although the particular focus of our research is on the states of mind associated with negative emotions, mental strain and high cognitive effort, the CLAS dataset could offer an adequate support to research of a wider scope, such as general studies on attention assessment, cognitive load assessment, emotion recognition, as well as stress detection. The dataset consists of synchronized recordings of physiological signals, such as Electrocardiography (ECG), Plethysmography (PPG), ElectroDermal Activity (EDA), as well as accelerometer data, and metadata of 62 healthy volunteers, which were recorded while involved in three interactive tasks and two perceptive tasks. The interactive tasks aim to elicit different types of cognitive effort and included solving sequences of Math problems, Logic problems and the Stroop test. The perceptive tasks make use of images and audio-video stimuli, purposely selected to evoke emotions in the four quadrants of the arousal-valence space. The joint analysis of success rates in the interactive tasks and the information acquired through the questionnaire and the physiological recordings enables for a multifaceted evaluation of specific states of mind. These results are important for the advancement of research on efficient human-robot collaborations and general research on intelligent human-machine interaction interfaces.

[Γ7.15] **Markova V**., T. Ganchev, "Technological support to stress level monitoring", Book Chapter 6 in *'Enhanced Living Environments: From Models to Technologies'*, IET Publisher, 2017, pp 133-160, ISBN: 978-1-78561-211-4. Chapter DOI: 10.1049/PBHE010E_ch

Stress is widely associated with increased health risks (heart & brain diseases, diabetes, cancer, behavioural disorders etc.). Moreover, a prolonged exposure to stress is known to negatively affect work performance, attitude, decision making etc. Furthermore, monitoring of stress levels and proper stress management are of crucial importance for Firefighters, Rescue crews, Police force and other high-risk professions in terms of mission success and workforce preservation. In this regard, here we overview the state-of-art in personal health monitoring systems, discuss the overall architecture and technology involved in the implementation of such functionality. A particular focus is put on the technology involved in assessment of brain activity and negative emotional states, which are linked to stress, behavioural, mental disorders etc. Recently, a lot of efforts and resources have been dedicated to the development of personal health systems for continuous monitoring and diagnosis of the individuals regardless of their location. Regardless of whether the personal health systems are designed as wearable, implantable, or portable, their data processing workflow can provisionally be divided in three main stages – data acquisition, data analysis, person/doctor communication. The functionality of such a personal health system is well suited to the needs of future monitors for stress and stress assessment aids during work or daily routine of individuals. We detail on the technology behind these three stages and outline the most recent trends in personal mobility, with focus on the introduction of intelligent, wearable, and implanted sensors.

From application point of view, we discuss the technological feasibility of stationary and mobile setups for stress level assessment and monitoring. Finally, we outline the current trends and future research directions and comment on some inherent limitations of stress level monitoring and on some challenges that remain unaddressed.

We overview the state-of-art in personal health monitoring systems, discussing the overall architecture, the functionality of individual components, and the technologies involved in the implementation of such functionality. Next, we discuss the technology involved in assessment of brain activity, negative emotional states, mental disorders, neurological diseases, which are linked to stress, behavioural, mental disorders etc. The focus here is on data acquisition and modelling methods and research for the discovery of causality between physiological measurements and mental stress. In Section IV, we outline the two main setups for stress assessment and monitoring – stationary and mobile, and discuss their technological feasibility. In this regard, we overview recent and on-going research and technology development projects and discuss interesting use cases, which make use of health and stress monitoring systems. Finally in Section V, we overview the current trends and future research directions and mention some inherent limitations of stress level assessment and challenges that remain unaddressed.

[**Γ7.16**] **V. Markova,** T. Ganchev, K. Kalinkov (2018). "Detection of Negative Emotions and High-Arousal Negative-Valence States on the Move", *Proc. of the 4th International Scientific Conference on Advances in Wireless and Optical Communications*, RTUWO-2018, Riga, Latvia, November 15–16, 2018, pp.61-65.

We present the overall design and implementation of a wearable system that is capable to continuously monitor and register negative emotions, high levels of emotion arousal, and high-arousal-negative-valence states from physiological signals, such as skin conductivity and ECG. This system builds on the client-server architecture. The commercially available wireless data acquisition devices Shimmer3 GSR+ and Shimmer3 ECG are used for the acquisition of physiological signals, which are then transmitted over a Bluetooth channel to a mobile phone. The mobile phone hosts the user interface and implements the data aggregation and transmission to the server, which carries all signal processing and classification tasks. Purposely developed software implements all data processing and recognition tasks on the server side and the user interface and the data communication on the client side. We report evaluation results for various setups of the binary detectors of negative emotions, high level of emotional arousal, and high-arousal-negative-valence states.

The experimental results support that the proposed approach has the potential to provide the required functionality for the automated detection of emotional arousal, negative emotional states, and high-arousal-negative-valence conditions from physiological signals. The reported detection accuracy for a single-stimuli recording is in the range 75% – 85%, which is insufficient for real-life applications. Future research efforts will be focused on the definition of appropriate setups, which would allow for the acquisition and use of contextual information, and on the development of advantageous signal parameterization methods, which derive signal feature vectors purposely-designed for the stress detection task.

[Γ7.17] V. Markova, T. Ganchev, „Constrained Attribute Selection for Stress Detection Based on Physiological Signals", *ACM Proc. of the 2018 International Conference on Sensors, Signal and Image Processing*, pp.41-45, 2018

We present a constrained attribute selection method that makes use of feature assessment based on the Fisher's separation criterion followed by variety reduction post-processing. The post-processing incorporates task-specific constrain into the feature selection process, as this is expected to facilitate the subsequent data modeling and classification stages. Here we validate the proposed method in an experimental setup oriented towards acute stress detection based on physiological signals. The experimental results support that the proposed method brings advantage, when compared to three other cases: (i) the full set of features, (ii) a subset selected based on prior knowledge, (iii) and a subset selected based solely on Fisher's separation criterion.

By applying the Fisher's selection criterion on a large feature set A, and taking advantage of different preselected core subsets AC,which are based on task-specific and domain-specific knowledge, we can obtain (partially) overlapping user-specific subsets of attributes that are relevant to a particular setup. Thus, the proposed method provides a mechanism for adjusting the attribute selection in the final feature subset AFC, so that it accounts for both the quality of attributes and the individual physiological characteristics of each specific person. Therefore, the proposed method provides a mechanism for steering the attribute selection process, so that we can obtain a small subset of relevant and reliable features, which is both user-specific and task-specific.

[Г7.18] V. Markova, T. Ganchev. “Three-step Attribute Selection for Stress Detection based on Physiological Signals”, *Proc. XXVII International Scientific Conference Electronics*, ET-2018, Sozopol, Bulgaria, September 13–15, 2018.

We present a three-step method for attribute selection that builds on person-independent and person-specific feature assessment stages. The first two steps aim to select a person-independent subset of attributes that are repeatedly selected for a large population of users. Next, this selection is intersect with a person-specific subset derived from the Fisher’s separation criterion. As a result, we obtain a subset of attributes which is both task-specific and customized to the quality of data of each particular user. The proposed method was validated on the ASCERTAIN database in an experimental setup oriented towards high-arousal negative-valence detection based on physiological signals. The experimental results support that the proposed method offers advantage in terms of detection accuracy when compared to other subset selection strategies. We deem the three-step attribute selection method would be applicable to other applications that involve processing and classification of physiological signals.

[Г7.19] V. Markova, T. Ganchev. “Automated Recognition Affect and Stress evoked by Audio-Visual stimuli”, *Proc. of the Seventh Balkan conference on lighting, BALKANLIGHT-2018,* Varna, Bulgaria, September 20–22, 2018.

In the present work, we consider the automated detection of negative emotions and high-arousal negative-valence (HANV) states, which are akin to acute stress occurring in specific context. We investigate the influence and intricacy which subjective perception of negative emotions and acute stress brings to the process of automated recognition of these states. For that purpose we experimentally evaluate the advantages of modelling based on the person-independent tags of the audio-video stimuli, and models built with the person-specific self-reported tags. Based on the self-reported tags, which are obtained with only tiny extra effort, we report a relative improvement of the HANV detection accuracy with up to 5%.

While the ECG-based features were observed to play a major role in the detection of negative emotions, the GSR- based features are known to be more reliable for the detection of emotional arousal, and therefore contributed towards the reliable detection of HANV states. A subset of carefully selected ECG and GSR-based features was found appropriate for the detection of the high-arousal-negative- valence state. It was demonstrated that models developed with the use of person-specific self-reported tags are advantageous for detection of HANV states. This provided additional option for improving the system accuracy in applications which assume cooperative users. Finally, summarizing all experimental results presented here, we report an average recognition accuracy of up to 67% for the detection of negative emotional states and over 68% for the detection of HANV states, based on a single recording. We consider these results promising and feel encouraged to continue with the development of a system that permits the combined evaluation in two subsequent trials.

[Г7.20] T. Ganchev, **V. Markova**, I. Lefterov, Y. Kalinin (2017). "Overall Design of the SLADE Data Acquisition System "*Advances in Intelligent Systems and Computing*", ISSN: 2194-5357, vol. 679, pp.56-65, 2nd International Conference on Intelligent Information Technologies for Industry, IITI 2017, 14 -16 September 2017. **SJR 0.174**

We present the overall design of a data acquisition system developed for the needs of the SLADE (Stress Level and Emotional State Assess-ment Database) database. The database consists of synchronized EEG, ECG, skin temperature (ST), and galvanic skin response (GSR) recordings, used in stress level assessment and recognition of emotional states. SLADE will facilitate the development of automated tools and services for stress-level assessment and monitoring.

Stress assessment in stationary setup offers the opportunity for the use of an extended sensor set and creation of representative database for stress assessment in controlled conditions. Here we presented the conceptual design of the technological framework used during Phase 1 of the SLADE data collection campaign and report baseline results for the automated detection of high arousal/low valence (HALV) events, which are akin to stress events occurring in specific context and application scenarios. We investigate the opportunities offered by the HALV detection results presented here, which are based on the binary detectors of arousal and valence. Baseline results from the combined use of various subsets of sensors and signal features are reported. The experimental results support that HALV can be detected with good accuracy and we expect that future developments, which make use of a more diverse set of signal descriptors will significantly increase the overall recognition accuracy.

[Г7.21] V. Markova, K. Kalinkov, P. Stanev, T. Ganchev (2017). "Automated Stress Level Monitoring in Mobile Setup". *Proc. of the IITI-2017*, September 14-16, 2017, Varna, Bulgaria, in "Advances in Intelligent Systems and Computing", ISSN: 2194-5357, vol.680, pp.323-331. **SJR 0.174**

We present the design of a mobile system for real-time stress-level assessment. The system combines wearable sensors, wireless data acquisition, and Cloud computing in order to collect and analyze physiological signals, such as, Galvanic Skin Response (GSR) and skin temperature. We report on the implementation of a specific use case, which incorporates functionality for real-time data logging and analysis. Experimental results demonstrate excellent recognition accuracy of affective arousal and decent accuracy for binary detection of valence. In addition, we also evaluate the feasibility for detection of high arousal/negative valence (HANV) events, which in specific setups can be connected to stress.

In the present work, we presented the overall design and the implementation of a system for real-time stress monitoring in mobile setup. The stress monitoring is based on readings of GSR and skin temperature on the left hand. The experimental evaluation of recognition accuracy reported here support the hypothesis that binary assessment of affective arousal, based on descriptors computed from GSR and skin temperature readings is feasible. Such a functionality facilitates the development of technology for real-time monitoring of stress in a mobile setup. In addition, we evaluated the possibility to detect positive/negative valence condition based on the same set of signal descriptors. Although the observed recognition accuracy of valence does not meet the requirements of real-life applications, we consider the experimental results quite interesting as these demonstrated the feasibility to detect specific instances of the high affective arousal/negative valence condition. In specific situations and context, the automated detection of high arousal/negative valence events can be interpret as the onset of stress condition. Depending on the application area, a team supervisor (or an operator) can immediately contact the person in order to instruct her/him on how to proceed further with her/his mission. Hypothetically, the last could be useful to enhance stress management in high-risk professions, in support of teams involved in medical assistance, and in the rehabilitation of patients who recover of severe trauma, such as injuries of the spinal cord, lower limbs etc.

1.3 Резюмета за публикациите от група „Г.8“

[Г8.1] K. Kalinkov, **V. Markova**, Preprocessing of PPG and EDA signals for detection of emotional and cognitive states via physiological signals, *Annual journal of TU-Varna*, 2021 in print

In the current paper we present a methodology for approaching the preprocessing of Photoplethysmography and Electrodermal activity for the detection of emotional and cognitive states in humans via physiological signals. We examine the effects of downsampling and segmentation of the PPG and segmentation and the separation of the Skin Conductance Level (SCL) and Skin Conductance Response (SCR) components of the EDA signal with both median and low pass filters. The results from our research point that for the purposes of emotions and cognitive load classification the most appropriate preprocessing is segmentation of 2 minutes which is the recommended length for frequency analysis of heart rate variability. Furthermore, we recommend the downsampling of the PPG to 64 Hz, which proved to be the lowest sampling frequency that doesn't introduce errors in the systolic peak detection and doesn't affect drastically the length of the Inter Beat Intervals (IBIs). For the separation of the SCL component of the EDA, we recommend the usage of median filter with window length of 75% of the sampling frequency, which introduces negligible artefacts, mainly in the beginning of the signal.

[Г8.2] N. Grozev, **V. Markova**, "Atmospheric Observation and Radio Signal Measurements over the Black Sea Region for Assessment of Tropospheric Radio Propagation and Potential Radio Interferences", Journal "Mathematical Modeling", vol4. issue 4, 2020.

Due to various interferences arising from the tropospheric propagation of radio waves over big water basins, it is necessary to study in detail the mechanisms of propagation and to improve the existing models for determining propagation factor or path loss profiles at different frequencies, especially in UHF bands, caused by the growing interest of mobile communications and especially 5G technologies. To get enough information about radio wave propagation over the Black sea area, the state of atmosphere above points of interest is studied in detail and the results are compared with real measured radio signals distributed between those points. The results are compared with basic theoretical computed models. The results showed more than 10 dB and from 6 to10 dB difference respectively for VHF and UHF between measurement and computed with Three way path loss model EMF levels for the favorable cases which might be due to additional ray in the receiver. A clear relationship between received EMF levels and wind speed but in combination with different abnormal tropospheric environments and relationship between absolute value of modified refractivity and the levels of received signals for the surveyed regions.

[Г8.3] К.Калинков**, В. Маркова**, Т. Ганчев, „Извличане на описатели от физиологични сигнали за разпознаване на емоции”, Списание „Компютърни науки и технологии “, бр.2, pp.34-41, 2018, ISNN 1312-3335. http://csejournal.cs.tu-varna.bg/cse_journal_2_2018.pdf

This report presents the results of research related to the extraction of descriptors from physiological signals for the recognition of emotions and stress. A large number of descriptors are known, both in terms of time and frequency, but only some of them are essential for recognizing emotions and stress. The current study aims to create a database with records of biomedical signals, which will then be used to validate algorithms for extracting descriptors and develop models for recognizing negative emotional states and stress. The Consensys Development Kit biomedical sensor system was used to record ECG, photoplethysmographic (PPG) signals and electrodermal activity on the hands of four volunteers. The participants are representatives of different age, social and gender groups. Each of them is exposed to a neutral stimulus to establish the normal values of the biosignals for the individual and 15 audio-visual stimuli, generating different emotional effects.

A comparative analysis of descriptors obtained in Matlab and LabVIEW environments with different recording lengths was performed. In the context of a larger goal to develop a methodology for automated recognition of negative emotional and stressful states with the help of elements of artificial intelligence, comparative studies of several main descriptors derived from ECG and PPG. The results show that for target applications the use of ECG or PPG signals are interchangeable options. In addition, the relationship between selected descriptors and the duration of physiological signal recordings was investigated. There was a strong fluctuation in the length of the recording on the assessment of heart rate variability in the frequency range.

[Г8.4] В. Маркова, Развиване на дигитална грамотност на ученици чрез компютърно моделиране, Клъстери и иновации в образованието, 5-7 Октомври, 2018,България

Information and communication technologies play an important role in modern education, which must meet the needs for developing new knowledge and skills in adolescents related to the effective use and understanding of digital technologies.

Nowadays, children from a very young age are exposed to the possibilities of information technology and the Internet. The development of children's digital skills and competencies is a prerequisite for the effective use of information technology, demonstration of skills for safe and healthy use of technology, as well as opportunities for recognizing threats in the digital environment. This paper presents various software tools that help to easily and excitingly develop digital skills among adolescents. Among the most accessible and attractive programming languages for children are Logo, Scratch, Kodu and Tynker.

Digital literacy includes a set of knowledge and competencies necessary for the full development of modern children. Visual programming environments allow students in the form of games to gain useful knowledge and skills that will help them in the future to effectively use information technology to acquire other key knowledge (mathematics, creativity, creativity, collaboration). This will help them in the future to be full participants in society and the economy.

[Г8.5] V. Markova, Cv. Dicheva, F. Feradov, Y. Kalinin, T. Ganchev, “SLADE -stress level and emotional state assessment database: phase 1”, Journal “Computer Science and Technologies”, vol.1, pp.60-68, 2016, ISNN 1312-3335. http://csejournal.cs.tu-varna.bg/cse_journal_1_2016.pdf

The report presents the concept and implementation of the SLADE (Stress Level and emotional state Assessment) database, which was created to assess stress levels and identify emotional states from biosignals.

SLADE contains electrocardiographic (ECG) and electroencephalographic (EEG) recordings, and galvanic skin resistance (electrodermal activity). The report provides a detailed description of the results of the first phase of implementation, which includes records from 10 clinically healthy volunteers. Within an hour, the volunteers were emotionally stimulated with the help of 40 one-minute audio-video stimuli with different emotion and degree of emotional arousal. After each video, the participants fill in a questionnaire in which they assess the level of impact on three indicators (valence, degree of arousal and dominance of emotion).

The distribution of the emotional impact of the individual stimuli in the coordinate system (emotion-arousal) is presented. The average values of the emotional impact for each of the selected video stimuli were determined. Subsequently, these tags will be used to create automated models for recognizing various emotional states.