REVIEW

by **Prof. Ivan Ganchev Garvanov, DSc**,
member of the Scientific Jury, appointed by the Director of the IR-BAN
№ 69/02.09.2024 г.

regarding: Dissertation work of **Adelina Georgieva Kremenska** on the topic "Design of a Brain-Machine Interface to various devices and services in the Internet of Things", submitted for the acquisition of the educational and scientific degree "DOCTOR" in field 5. "Technical Sciences", professional direction 5.2 . Electrical engineering, electronics and automation with a scientific specialty - "Application of the principles and methods of cybernetics in various fields of science", with scientific supervisors: Prof. Dr. Anna Kostadinova Lekova - Institute of Robotics - BAS and Prof. Dr. Georgi Petrov Dimitrov - University of Library Studies and Information Technologies

1. Description

At the first meeting of the Scientific Jury, held on 09/03/2024, I was selected to write a review and received a complete set of documents electronically. The documents are: dissertation; abstract; a list of printed scientific publications on the topic of the dissertation; publications on the topic of the dissertation in full text; other documents related to the defense of the dissertation work.

2. Relevance, aim and tasks

The topic of the dissertation work is extremely relevant considering the rapid development of "smart technologies" and their connectivity. The development of

Brain-Machine Interface to various devices and services in the Internet of Things is a promising scientific direction requiring multidisciplinary knowledge and skills such as: signal processing, data processing, detection, recognition and classification of mental activity and many others. The scientific and scientifically applied results obtained in the dissertation are of a practical orientation.

The aim of the dissertation work is to create a system architecture for the design of a Brain-Machine Interface applicable to various EEG devices and IoT services.

To achieve the goal set in the dissertation, the following tasks have been formulated:

Task 1. To make an overview and analysis of the scientific developments dedicated to the topic of the dissertation. Study of existing software products relevant to the topic of the doctoral studies and selection of the most suitable ones.

Task 2. To design and develop a model for registering, transmitting, analyzing and processing EEG signals in order to convert them into commands for controlling devices and services in the Internet of Things.

Task 3. To develop methods and algorithms for processing EEG signals. Design and development of open source software that can be applied to various EEG devices with the ability to transmit EEG data, characteristics and metrics over the Internet.

Task 4. To conduct experimental studies of the developed software for verification of the working capacity of the Brain-Machine Interface.

3. General characteristics of the dissertation work

The submitted Dissertation work consists of 134 pages organized in an introduction, four chapters, a conclusion, directions for future work, contributions, a list of publications on the dissertation, a list of noted citations and three appendices.

Chapter 1 examines and analyzes the software technologies for brain-machine interface design, as well as the tools for connecting and communicating with people and objects in the Internet of Things.

Chapter 2 explores existing software methods for designing and integrating an EEG-based brain-machine interface into the Internet of Things. Based on the research done, an innovative model has been developed for the transmission, analysis and processing of EEG signals and their conversion into commands for controlling devices and services in the Internet of Things.

Chapter 3 discusses methods and algorithms for designing and integrating an EEG-based brain-machine interface into the Internet of Things. Based on the research done, an open source software applicable to various EEG devices has been designed and developed.

Chapter 4 verifies the developed software through experimental testing.

The results in the dissertation are presented in 34 figures and 5 tables. 102 literary sources were used.

4. Contributions

I accept all the contributions of the doctoral student and consider them to be of a scientific and scientific-applied nature. In his research, the doctoral student confirms some known facts, an existing scientific field is enriched with new knowledge, and some of the newly obtained scientific results are proposed to be applied in practice.

5. Abstract

The presented two versions of the abstracts in Bulgarian and English faithfully reflect the content of the dissertation and comply with the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria. From the

attached declaration of originality of the presented results, as well as from the submitted publications on the dissertation, it can be judged that the described results are a personal work of the doctoral student.

6. Assessment of compliance with minimum national requirements

PhD student Adelina Georgieva Kremenska has approved parts of her dissertation work in four scientific publications, two of the publications are indexed in Scopus or WoS, one has IF with Q4 and the second has SJR. One of the papers is in press but will be published in IEEE and indexed in Scopus. One of the articles was published on the Preprints platform. Two citations to one of her publications are noted.

According to the minimum national requirements for obtaining of the educational and scientific degree „Doctor" in professional direction 5.2. Electrical engineering, electronics and automation, the required scores are to be at least 30 for the group of indicators G. All presented publications on the dissertation work are in publications that are referenced and indexed in world-renowned databases with scientific information and are scored with 40/ n (where n is the number of co-authors) or prorated based on the contribution protocol. Since no separation protocol has been provided, I assume that each of the co-authors on the publications has contributed equally. In my opinion, the total score for the Group G indicators is equal to 55 points, which exceeds the required minimum of 30 points.

The protocol of the anti-plagiarism system StrikePlagiarism has shown conclusively that the dissertation is original and authentic.

7. Notes and Recommendations

I have no notes or recommendations for the doctoral student.

8. Final comprehensive assessment

I believe that the submitted dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria. The achieved results give me reason to give a positive assessment with complete conviction and I recommend to the honorable Scientific Jury to award the educational and scientific degree "Doctor" to **Adelina Georgieva Kremenska** in professional field - 5.2 "Electrical engineering, electronics and automation".

16.09.2024

Sofia

/Prof. DSc Ivan Garvanov/