OPINION

on a dissertation work for the acquisition of the educational and scientific degree "doctor" in area 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"

Author of the dissertation: M.Sc. Eng. Adelina Kremenska

Dissertation Topic: Designing a Brain-Machine Interface to Different Devices and Services in the Internet of Things

Member of the scientific jury: Velislava Noreva Lyubenova, Professor, DSc, prepared the opinion on the basis of order No. 69/02.09. 2024 of the Director of IR-BAN, Prof. Dr. August Ivanov

1. Brief biographical data

Mag. Eng. Adelina Kremenska was born in Sofia in 1992. She graduated from the Sofia Mathematical High School, and in 2015 she defended her master's degree in Telecommunications Engineering at the Technical University-Sofia. She worked as a junior specialist in radio planning, in radio planning and optimization at Vivacom, and from 2019 until now she is an Oracle software developer at "Information Service". At the BAS, she has been working since 2020 in the fields of interactive and socially supportive robotics on EEG-based brain-machine interface. She has been enrolled as a part-time doctoral student since 2020 in the "Interactive Robotics and Control Systems" section of the Institute of Robotics - BAS.

2. Relevance of the problem developed in the dissertation in scientific and scientific-applied terms

In our time, Internet technologies are developing at a rapid pace, some of which are related to the management of a wide range of everyday devices through various interfaces: smartphones, smart glasses, etcA new alternative is related to the development of mobile non-invasive Brain-Machine Interface (MBI) based on encephalography (EEG), which enables people to directly control with their thoughts Internet-connected devices or assistive robots in their smart homes. One of the most important challenges is the correct interpretation of people's intention encoded in the raw EEG brain signals, which are often of low accuracy due to the presence of noise, lack of human concentration, and others. To overcome these problems, original methods and algorithms for registering, transmitting, analyzing and translating EEG signals for controlling devices and services in the Internet of Things have been developed and researched in the dissertation.

3. Degree of knowledge of the state of the problem and of the literary material

The doctoral student presented a detailed overview (44 pages). The technologies for the design and application of MBI, as well as for the design and application of EEG-based MBI in the Internet of Things (IoT) for connecting and communicating with devices and services are reviewed. 102 sources are cited in the work. The PhD student has studied and knows in detail the state and problems in this field.

4. General characteristics of the dissertation work

The dissertation consists of 129 pages (introduction, 4 chapters, conclusion, list of used literature, list of publications on the topic of the dissertation (4), noted citations and appendices.

✓ The object area and the subject of research are defined. An overview analysis of the technologies for the design and application of MMI, as well as for the design and application of EEG-based MBI in the Internet of Things for connecting and

communicating with devices and services, has been carried out. The purpose and tasks of the dissertation are determined.

✓ 20 technologies for programming in IoT and for programming MBI in IoT were investigated. A programming software technology (IBM's IoT technology - Node-RED) was chosen for the development of open source software to use the device APIs. 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.

✓ Original methods and algorithms have been developed for the design and integration of an EEG-based machine-brain interface in the Internet of Things. A system architecture for communication with devices and services in the IoT with opportunities for application in practice has been designed and developed. The proposed innovative methods and algorithms offer visual MBI programming in a web environment with pre-coded software nodes. New custom open-source nodes have been created and added to the Node-RED library (GitHub) that facilitate the user in building an MBI for the wireless transmission of the EEG data.

✓ Experimental studies have been carried out and their results verify the developed EEG-based brain-machine interface. The proposed study experimentally validates the openBCI toolkit

✓ The dissertation ends with a conclusion summarizing the key findings of the study and the interpretation of the obtained results.

There is a correspondence between the chosen research methods and the set goal and tasks of the dissertation work. The doctoral student demonstrated in-depth knowledge of the researched problems and proposed successful methods and algorithms for solving them. The main goal and set tasks have been fulfilled. The obtained results and publications are proof of the good preparation and creative abilities of the doctoral student.

5. Contributions to the dissertation work and abstract

I accept the contributions in the dissertation that I consider to be scientific and applied.

The presented abstract of the dissertation, in a volume of 45 pages, is structured correctly, correctly reflects the content of the dissertation and gives an idea of the problems under consideration, as well as the contributions of the dissertation work.

6. Publications and citations in the dissertation work

4 publications are indicated for the dissertation work. One of the publications is in a journal with an impact factor referenced in WoS, the other two publications are from reports of participation in prestigious international conferences. One publication is in print. 2 citations noted. Publications reflect the main contribution to the work and leadership role of the PhD student.

7. Opinions, recommendations and notes

The dissertation has been thoroughly developed and is a complete research work. Mag. Eng. Kremenska has carried out a systematic study of the problem and has proposed original scientific and applied results. They fully meet the purpose of the dissertation work. The assigned tasks correspond to the declared contributions.

8. Conclusion with a clear positive or negative evaluation of the dissertation work

I highly appreciate the work done and the results obtained in the dissertation. The doctoral student demonstrates good knowledge in the specific field and scientific potential for the realization of original ideas. The dissertation is in a form and volume corresponding to the

requirements. In it, results of a scientific and applied nature were obtained, which represent an original contribution to science and were published in renowned specialized scientific publications. On the basis of the above, I believe that the dissertation work of M.Sc. Eng. Adelina Kremenska meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Rules for its Implementation, the Rules of the BAS for the Development of the Academic Staff for the Acquisition of the Educational and Scientific Degree "Doctor" and the Internal Rules of IR-BAS .

Based on the analysis, I give a positive assessment of the developed dissertation work and consider it justified to offer to M.Sc. Eng. Adelina Kremenska to acquire the educational and scientific degree "doctor" in scientific 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".

1.10.2024 г.   Member of the jury: