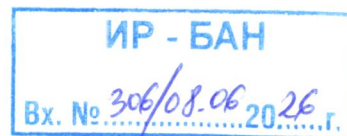


OPINION



by Prof. DSc. Velislava Noreva Lyubenova

Institute of Robotics, Bulgarian Academy of Sciences

on a dissertation submitted for the award of the educational and scientific degree “Doctor” (PhD)

Field of Higher Education: 5. Technical Sciences

Professional Field: 5.2 Electrical Engineering, Electronics and Automation

Doctoral Programme: Application of the Principles and Methods of Cybernetics in Various Fields of Science

Author: Gagandeep Kaur

Supervisor: Prof. Anna Lekova, PhD

1. General Presentation of the Procedure and the Doctoral Candidate

By Order No. 44/16.04.2026 of the Director of the Institute of Robotics, Bulgarian Academy of Sciences (IR-BAS), I was appointed as a member of the Scientific Jury for the defense of the dissertation entitled “A Neurocognitive Brain-Computer Interface-Based Approach for Identifying Emotional and Mental States” submitted for the award of the educational and scientific degree “Doctor” (PhD) in Field of Higher Education 5. Technical Sciences, Professional Field 5.2 Electrical Engineering, Electronics and Automation, Doctoral Programme “Application of the Principles and Methods of Cybernetics in Various Fields of Science”.

The dissertation was prepared by Gagandeep Kaur, an independent doctoral student at the Interactive Robotics and Control Systems Department (IRCS), Institute of Robotics – BAS, under the supervision of Prof. Anna Lekova, PhD.

This opinion has been prepared in accordance with the requirements of the Academic Staff Development Act of the Republic of Bulgaria, the Regulations for its Implementation, and the Internal Regulations of the Institute of Robotics – BAS.

The materials submitted by Gagandeep Kaur comply with the aforementioned regulatory requirements.

2. Relevance of the Research Topic

The topic of the dissertation is relevant and significant due to the need for objective methods for assessing cognitive and emotional states. Of particular value is the focus on a real educational environment, since teacher fatigue is a serious issue associated with professional burnout, reduced effectiveness, and decreased engagement. At the same time, objective methods for assessing fatigue under real-life conditions remain insufficiently developed.

The choice of suggestopedic teaching—an innovative educational method of Bulgarian origin—adds originality, scientific significance, and practical value to the research.

3. Knowledge of the Research Problem

The dissertation demonstrates that the doctoral candidate possesses solid theoretical knowledge in the field of EEG-based brain-computer interface (BCI) systems, signal processing, and neurocognitive research. The literature review is comprehensive and systematic and correctly identifies key gaps in existing studies, thereby justifying the need for the proposed methodology.

4. General Characteristics and Evaluation of the Dissertation

The dissertation comprises 123 pages and includes an introduction, four chapters, conclusions, directions for future work, contributions, publications, references, and appendices. The presentation is logically structured and consistent with the stated objective of developing an EEG-based brain-computer interface for the analysis and assessment of emotional and mental states.

The research tasks are clearly formulated and include an analysis of existing approaches, development of a model and methodology for EEG signal processing and analysis, design of an experimental protocol, and its application in a real professional environment.

Chapter One provides a comprehensive literature review and identifies the main limitations of existing studies. Chapter Two presents the theoretical foundations and methods used for EEG acquisition, preprocessing, and analysis. Chapter Three introduces an EEG-based methodology for assessing cognitive and emotional states, while Chapter Four presents and discusses the results of the experimental study.

The methodological framework is appropriate for the stated objectives and enables a reliable interpretation of the obtained results. The findings indicate changes in EEG activity following prolonged teaching activity, and the interpretations provided are well-argued, balanced, and scientifically sound.

Overall, the dissertation represents a completed scientific study with a clearly defined objective, an appropriate methodology, and results possessing both scientific and practical value.

5. Contributions and Significance of the Dissertation

I accept the contributions formulated by the doctoral candidate as correctly reflecting the achieved results and as directly deriving from the objectives and tasks of the dissertation.

As a significant scientific contribution, I evaluate the development of an EEG-based model and methodological framework for the analysis and assessment of cognitive and emotional states through a brain-computer interface, which expands the possibilities for objective investigation of cognitive states under real-world conditions.

A significant scientific-applied contribution is the development and validation of an experimental protocol for studying cognitive states in a real educational environment involving suggestopedia teachers.

In my opinion, the dissertation contains scientific and applied contributions with the necessary degree of originality, scientific value, and practical significance required for the award of the educational and scientific degree "Doctor" (PhD).

6. Dissertation Abstract

The dissertation abstract accurately reflects the main content of the dissertation and is structured in accordance with established requirements. It presents the objectives, tasks, methodology, main results, and contributions of the research.

The presented results, conclusions, and contributions correspond to those contained in the dissertation.

There are minor technical and editorial inaccuracies that do not substantially affect the presented results, conclusions, or the overall positive assessment of the dissertation.

7. Evaluation of Publications and Personal Contribution of the Doctoral Candidate

Several publications related to the dissertation topic have been presented, reflecting the main stages and results of the conducted research. Among them, a publication in the journal *Brain Sciences* (Q2) stands out, demonstrating the international visibility of part of the obtained results. The publication record indicates that the research findings have been disseminated and discussed within the scientific community.

The personal contribution of the doctoral candidate is clearly evident throughout all stages of the research—from the study and analysis of existing EEG-based approaches, through the development of the methodological framework and experimental protocol, to data processing, result analysis, and formulation of conclusions. The presented results and their interpretation demonstrate a profound understanding of the subject matter and the ability to conduct independent scientific research.

I consider the presented publications to be directly related to the dissertation topic and supportive of the claimed scientific and scientific-applied contributions.

8. Comments and Recommendations

I have the following comments and recommendations, which do not diminish the scientific value of the dissertation:

1. The assessment of cognitive states is based primarily on EEG spectral markers. Future studies could benefit from the inclusion of subjective questionnaires, behavioral indicators, or additional physiological measurements to enrich the analysis and provide more comprehensive validation of the obtained results.
2. The interpretation of the observed EEG changes as indicators of mental fatigue should be approached with caution, since some of the identified alterations may also be associated with prolonged cognitive engagement, attention, and compensatory brain activity. Further studies are needed to distinguish more precisely among different cognitive states.
3. I recommend extending future investigations to a larger number of participants and to other groups of teachers and professional populations, which would allow broader verification of the applicability and generalizability of the proposed methodology.

3. I recommend extending future investigations to a larger number of participants and to other groups of teachers and professional populations, which would allow broader verification of the applicability and generalizability of the proposed methodology.

These comments are intended as recommendations for future work and do not call into question the quality, completeness, or scientific merits of the dissertation.

CONCLUSION

The dissertation entitled “A Neurocognitive Brain-Computer Interface-Based Approach for Identifying Emotional and Mental States” by Gagandeep Kaur represents a relevant, independent, and completed scientific study in the field of EEG-based brain-computer interfaces and the neurocognitive analysis of mental states.

The dissertation contains scientific and scientific-applied contributions related to the development of a novel model and methodology for the assessment of emotional and cognitive states, as well as their experimental validation in a real educational environment. The obtained results contribute to the advancement of methods for the objective assessment of cognitive states in working adults and expand the applicability of EEG-based approaches in natural working environments.

I conclude that the dissertation meets the requirements of the Academic Staff Development Act of the Republic of Bulgaria, its Implementing Regulations, and the Internal Regulations of the Institute of Robotics – BAS.

Based on the above assessment, I give my positive evaluation and recommend that the Scientific Jury award Gagandeep Kaur the educational and scientific degree “Doctor” (PhD) in Field of Higher Education 5. Technical Sciences, Professional Field 5.2 Electrical Engineering, Electronics and Automation, Doctoral Programme “Application of the Principles and Methods of Cybernetics in Various Fields of Science.”

07.06.2026

Sofia

/V. Lyubenova/