

REVIEW

From: *Prof. DSc Eng. Ivan Ganchev Garvanov*
University of Library Studies and Information Technologies
MON: 4.6. "Informatics and Computer Science"

Subject: Dissertation for awarding an educational and scientific degree
"Doctor" in District 5. "Technical Sciences", professional field 5.2.
"Electrical Engineering, Electronics and Automation" with a
scientific specialty – "Application of the principles and methods of
cybernetics in various fields of science"

Grounds for submitting the review: participation in the scientific jury for the
defense of the dissertation according to Order No. 60/03.06.20206. of the
Director of the Robokit Institute.

Author of the dissertation: *Eng. Svetoslav Emilov Kremenski*
Topic of the dissertation: ***Integration of Brain-Machine Interface
and Social Robots with Application in
Different Subject Areas***
Supervisors of the PhD student: *Prof. Dr. Anna Kostadinova
Lekova – Institute of Robotics-BAS and Prof. Dr. Snezhanka Kostova – Institute
of Robotics-BAS*

1. Dissertation information

The dissertation was taught under the doctoral program "Application of the principles and methods of cybernetics in various fields of science" of the Robokit Institute. I don't know PhD student Kremenski, but his CV shows that he is a professional with many years of experience in the field of mobile communications.

2. General characteristics of the presented dissertation

At the first meeting of the Scientific Jury, I was selected to write a review and received the following documents in electronic format:

- *Dissertation in Bulgarian;*
- *Abstract in Bulgarian and English;*
- *Doctoral student's curriculum vitae;*
- *Copy of an order for the formation of a scientific jury;*

- *List of printed scientific publications on the topic of the dissertation;*
- *Copy of the publications on the topic of the dissertation.*

The submitted dissertation consists of 177 pages formatted into an introduction, four chapters, a conclusion, compulsions and a bibliography. To illustrate the results, 30 figures and 2 tables are attached. 138 literary sources were used.

The aim of the dissertation is to develop and validate a universal methodology for the integration of various devices for the brain-machine interface and social robots in IoT, which will be tested in the field of neuromarketing.

To achieve this goal, the following tasks are formulated:

- 1. To make a literary review and analysis in the subject area of the dissertation.*
- 2. To analyze the existing software platforms for integrating EEG-based brain-computer interface and social robots into the Internet of Things. Study of methods for transforming social robots into IoT "things" depending on their hardware and software configurations. Study of machine learning methods to characterize and classify brain activity in decision-making or choice.*
- 3. To propose and research a methodology for integrating MMI and social robots into IoT for different subject areas. Development of original methods and algorithms for integrating various devices for MMI and social robots through the Node-RED platform.*
- 4. To validate the proposed methodology with the openBCI device and the social robot Furhat, with application in the field of neuromarketing to study the spontaneous emotional reactions of consumers when advertising products and their choices. Development of experimental and demonstration software.*

The structure of the dissertation is logically sound and consistent:

The annotation formulates the purpose and objectives of the dissertation and indicates the contributions of the dissertation.

Chapter One provides a thorough critical overview and analysis of MMI technologies, the essence of EEG signals, and social robots (such as Pepper and Furhat).

Chapter Two is devoted to system analysis of software platforms for integration and research of existing statistical methods and algorithms for machine learning, applied on EEG data.

Chapter Three contains the actual research and design part of the PhD student, presenting the new methodology for IoT integration through the Node-RED platform.

Chapter Four demonstrates the practical verification and experimental testing of the proposed solutions in a real business and research task.

The presentation follows a clear research logic – from a theoretical framework to realization and comparative analysis of the results.

The topic of the dissertation is extremely relevant both from a scientific and practical point of view.

The dissertation fits into the modern areas of research in the field of Brain-Computer/Machine Interfaces.

3. Evaluation of the scientific and applied scientific results obtained

The dissertation of Eng. Svetoslav Kremenski is an independent, logically structured and methodologically sound scientific research with a clearly expressed practical orientation.

The goal has been achieved, the tasks have been realized, and the working hypothesis has been proven through the scientific results obtained. The author demonstrates very good theoretical training and skills in applying methods for extracting knowledge from data.

In view of the above, I believe that the dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria and the Regulations for its implementation.

I have not noticed plagiarism in the publications and the dissertation under this procedure.

4. Evaluation of scientific and applied scientific contributions

The results of the research of Eng. Svetoslav Kremenski enrich the existing scientific field with new knowledge.

The scientific and applied scientific contributions indicated in the dissertation can be summarized as follows:

1. A conceptual model for interaction with social robots through EEG signals in an IoT environment, implemented through the Node-RED platform, has been proposed and developed. The main functional requirements for transmitting, analyzing and processing EEG signals and their conversion into control commands for social robots are formulated.

2. Original methods and algorithms for transforming social robots into IoT devices have been proposed and investigated - for Pepper via MQTT and Python child processes in Node-RED, and for Furhat via HTTP protocol with GET/POST requests from the behavior control software module, processed in Node-RED from an HTTP receiving node.

3. An IoT-based architecture has been developed for the integration of EEG-based MMI and social robots, implemented in Node-RED with ready-made

nodes for EEG devices and visual programming, which, through the implementation of external Python daughter processes, provides dynamic management of hardware and software resources and asynchronous data exchange.

4. New methods and algorithms have been proposed and developed to analyze the dynamic similarity of spatio-temporal EEG signals, reflecting the spontaneous reactions of users, by deriving characteristics based on the second derivatives of the power of the signals.

5. A new neuromarker has been defined to evaluate user choice using Pearson correlation in sliding windows. It measures the spatio-temporal similarity of reactions (up to ~2 seconds) and offers a computationally easier alternative to classical wavelet analysis and Fourier transform.

6. The methodology and software for real-time neuromarketing research have been experimentally verified through the integration of OpenBCI and the social robot Furhat.

The contributions are mainly scientifically applied in nature, with the main value being systematization, comparative analysis and practical approbation.

5. Evaluation of dissertation publications

The PhD student Eng. Svetoslav Kremenski has tested parts of his dissertation in three publications – all in English. The three reports are a joint development of the PhD student with his supervisors. All publications submitted under the competition are on the topic of the competition. From these publications it can be judged that the described results are original and personal work of the PhD student. and one is visible in Scopus and WoS. The third is printed in WSEAS TRANSACTIONS on SIGNAL PROCESSING.

These publications are sufficient to meet the minimum national requirements for a PhD in 5.2. "Electrical Engineering, Electronics and Automation".

According to the minimum national requirements for obtaining a PhD degree in the professional field 5.2. "Electrical Engineering, Electronics and Automation", defined in Art. 2b, para. 2 and 3 of the Law on the Prevention of Corruption and Corruption and respectively under Art. 24, para. 1 of the Regulations for the Implementation of the Law on the Prevention of Corruption and Corruption is required to have at least 30 points on the indicators from Group G. The presented publications on the dissertation form a total sum of the points for the indicators from Group D equal to 30 points, which covers the required minimum of 30 points. There were also 5 citations.

6. Evaluation of the abstract

The presented abstract reliably reflects the content of the dissertation and corresponds to the requirements of the Law on Abstract Abstract and Abstract.

7. Critical notes, recommendations and questions

Some of the results presented in the dissertation have not been reflected in the publications of the dissertation and my recommendation is that they be published.

I allow myself to recommend to Eng. Svetoslav Kremenski to continue working and publishing the results obtained by him in publications indexed in Scopus and WoS.

8. Conclusion

I believe that the presented dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Regulations for the Implementation of the Law on Robotics at the Bulgarian Academy of Sciences and the specific requirements of the Institute of Robotics at the Bulgarian Academy of Sciences. The results achieved give me grounds to give a positive assessment with full conviction and I recommend to the honorable Scientific Jury to award the educational and scientific degree "Doctor" to Eng. Svetoslav Kremenski in Professional Field 5.2. "Electrical Engineering, Electronics and Automation" with a scientific specialty – "Application of the principles and methods of cybernetics in various fields of science".

30.06.2026 / Sofia

Signature:

/prof. Dr. Ivan Garvanov/