Dr hab. inż. Aleksandra Kawala-Sterniuk
Profesor Uczelni
Wydział Elektrotechniki, Automatyki i Informatyki
Politechnika Opolska
ul. Prószkowska 76
45-758 Opole
a.kawala-sterniuk@po.edu.pl

OPOLE UNIVERSITY OF TECHNOLOGY

Opole, 14.08.2023 r.

Review Report on Doctoral Thesis

PhD candidate: **Mgr inż. Bernadetta Bartosik**
Thesis title: **"A method for measuring trust and attractiveness of presented faces based on brain activity measurements and machine learning"**
Supervisor: **dr hab. Grzegorz Marcin Wójcik, prof. UMCS, prof. PJATK**
Co-Supervisor: **dr hab. Aneta Brzezicka, prof. SWPS**
Institution: **Polish-Japanese Academy of Information Technology in Warsaw**
Doctoral Study Programme/Scientific Discipline: **Technical Information Technology and Telecommunications** (Informatyka Techniczna i Telekomunikacja)

This review has been carried our in response to **Prof. dr hab. Maria Elżbieta Orłowska** (Head of Scientific Council for Computer Science Discipline) invitation from 22nd of June 2023.

The purpose of this review is to determine whether this doctoral dissertation, authored by **mgr inż. Bernadette Bartosik**, meets the requirements for theses at this stage of education (defined in art. 13., ust. 1. Ustawy o stopniach i tytułach naukowych) and whether it meets the conditions listed in the following points:

1. Relevance of the chosen dissertation topic.

Ad. 1. This dissertation mainly focuses on the implementation of machine learning-based (ML-based) methods for classification and analysis of electroencephalography (EEG) signals. It is a very up-to date topic, which rises interests of numerous scientific groups all over the world.
The growing interest of the research domain presented in the thesis particularly over the past decade affected rapid evolution of tools and techniques applied for analysis of biomedical signals, such as among the others - Machine Learning. It also improved both medical and non-medical applications of these signals.
This dissertation focuses on the use of EEG signals to gauge trust through brain activity measurements and to explore the impact of facial attractiveness on perceived trustworthiness.
The chosen topic is **up-to-date** and **relevant** to the scientific discipline: **Technical Information Technology and Telecommunications**.

2. Definition and fulfilment of the dissertation objectives.

Ad. 2. The PhD candidate defined the following research goals:

- Pilot experiment:
  - Building a classification model that predicts trust ratings based on the face evaluator's personality traits.
  - Building a classification model that predicts attractiveness ratings based on the face evaluator's personality traits.
  - Determining which personality traits have the greatest impact on trust and attraction-related decisions.
- Main experiment:
  - Building a classification model that predicts trust ratings based on the collected EEG signal.
  - Building a classification model that predicts attractiveness ratings based on the collected EEG signal.
  - Determining which brain areas are active when making trust decisions and evaluating attractiveness.

Also the below listed hypotheses were formulated:
H1: It is possible to predict trust ratings based on the survey participant's personality traits.
H2: Attractiveness ratings can be predicted based on the survey participant's personality traits.
H3: There are personality traits that have a significant impact on both trust and attractiveness ratings.
H4: One can predict the trust decision regarding the presented faces based on the average electrical charge of the brain.
H5: It is possible to predict the attractiveness rating of the presented faces based on the average electrical charge of the brain.

The research objectives were divided into **two** parts - the pilot part and the main part. In the pilot part, experiments were carried out mainly aimed at trust and attractiveness based on a photo (survey evaluation); while in the main part of the experiment, EEG signals were used for this. In both parts, an appropriate Machine Learning model was built.

In addition, **5** research hypotheses were defined, which are closely related to the research objectives. The aim of the study was to obtain data and train the ML model to assess attractiveness and trust as a reaction to a photo based on the analysis of EEG signals.

The results obtained were at the level of **78%** for the trust variable and **76%** for the attractiveness variable. These results allowed me draw conclusions about the effectiveness of the proposed method and they **meet the requirements for doctoral theses**.

3. Evaluation of the obtained results in terms of significant contribution to the scientific field.

Ad. 3. As mentioned above - **two** parts of experiments were defined and carried out. Also, the PhD candidate defined **5** hypotheses, which were fulfilled. The subject of the work is extremely interdisciplinary, it combines various fields of science, such as computer science, biomedical engineering, psychology and medicine.

The use of machine learning in the analysis of biomedical data is currently a very trendy issue. In my opinion, based on the research results obtained and the selected research methods and tools, this work has a significant impact on the development of the scientific discipline: **Technical Information Technology and Telecommunications**.

4. **Dissertation content.**

Ad. 4. The thesis presents the results of research on trust and attractiveness (as reactions to photos) based on EEG analysis using methods based on machine learning. The research was conducted using a clinical electroencephalograph (EGI) from the Department of Neuroinformatics laboratory and Biomedical Engineering of the Maria Curie-Skłodowska University in Lublin, which enabled data recording with a sampling frequency of up to **500 Hz**. Data were recorded from a HydroCel GSN cap consisting of **256** electrodes.

The experiments were designed using the OpenSesame software. During the experiments, study participants were visually stimulated by pictures of faces. These photos came from two databases: MR2 and DEFSS. **24** photos were selected (based on previous statistical analysis during the pilot part of the experiment). The study involved **61** participants aged **18-23**. Registration for the study was carried out using an online form. Participant data was anonymised. Only right-handed, healthy men took part in the study. The obtained results were respectively **78%** for trust and **76%** for attractiveness.

5. Evaluation of the formal aspects of the thesis.

Ad. 5. The dissertation consists of **85** pages, including the table of contents, which consists of **102** references. It contains **7** chapters (including References), **25** figures, **14** tables and **15** equations.

The first chapter contains a brief introduction to the topic, motivations, research goals and hypotheses. The second chapter describes the theoretical basis of electroencephalography and the structure of the brain. The third chapter describes the methods of signal analysis. The fourth chapter presents the conducted experiments. The fifth chapter contains the obtained results. Chapter six contains a discussion. In the seventh chapter (without a number) there is a bibliography.

The work is written entirely in English.

In the further part of this dissertation review, I will point out both the positive and negative features of the doctoral thesis.

6. Positive qualities of the thesis.

Ad. 6. The experiment design is very well organised and the hypotheses well defined. The work is short, concisely written, but efficiently presents research problems and their solutions. The described problem has been solved. Figures' and tables' quality is proper.

Based on the dissertation content the author showed the knowledge and ability to define a scientific problem, presented ways to solve it and experimentally verified the proposed methodology. Additionally, the PhD candidate authored and co-authored few, scientific papers with an impact factor, strongly related with with this thesis topic.

Also, the proposed research is very interesting and innovative. Nowhere in the literature have I been able to find an identically designed experiment using the methods proposed by the author.

An attempt to write a thesis in a foreign language for a PhD student - English also deserves admiration.

7. Negative aspects of the thesis - issues for discussion.

Ad. 7. Below my critical comments:

- Trying to write a dissertation in a foreign language is very challenging. Unfortunately, in this case it was hard to read the work due to the level of language and the presence of language calques. The English language allows to reach a wider audience, but it would be worth giving this thesis to a native English speaker to check the language beforehand.
- The work structure is very chaotic. Chapter Two is labeled Electroencephalography and goes straight to the section on the structure of the brain without any introduction to Electroencephalography. This is then followed by a subsection on the history of electroencephalography, montage, and EEG bands. The second chapter should be better titled "Theoretical Foundations". But this is just a minor remark.
- There is no literature review chapter describing similar, already existing solutions, experiments or studies. It would improve thesis' quality.
- Citations appear throughout the work inconsistently.
- There are no time or time-frequency graphs of the recorded signals.
- Why did the author use the SPSS tool?
- 61 participants in the study, was it planned or were there any issues with the recruitment procedure?
- Why did the author limit the research to right-handed males only?
- What were the exact exclusion criteria for study participants?
- The discussion, which is the clue of the whole work, was contained in only two pages.
- There is no description of further research plans or work development.
- The work does not contain information on the bioethics committee. Has it been obtained?
- Out of 102 literature items, only 26 are current (latest) from 2017-2023.
- There is no description, no appendix on the candidate's achievements, such as a list of publications, awards, information on participation in research or scientific projects.

8. Summary assessment.

Ad. 8. In this thesis, the PhD candidate has displayed a grasp of the research process. She was able to formulate and solve **5** non-trivial hypotheses and design and develop rather efficient ML-based algorithms. The overall work is very interesting.

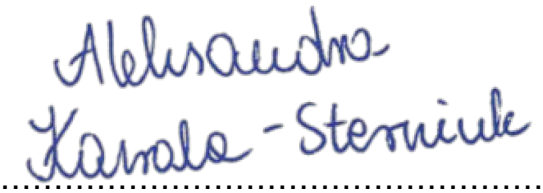
It is a pity that the doctoral student did not boast of her scientific achievements. I was able to find information about her participation in projects such as:

- 2021–2023 – Ochrona podstawowych praw przy wykorzystywaniu technologii cyfrowych w usługach e-zdrowia (REINITIALISE). Horyzont 2020, No. 952357, during which she was on a research internship at the University of Ancona;
- 15.07.2021–15.07.2022 – Zrozumieć mgłę mózgową – badania zespołu przewlekłego zmęczenia po przebyciu COVID-19. Grant Interwencyjny NAWA. No. BPN/GIN/2021/1/00019/U/00001, where she was the contractor.

Despite the short "list" of positives and the slightly longer list of negatives, the overall conclusion about the thesis is **positive**. In my opinion, the doctoral dissertation of **mgr inż. Bernadetta Bartosik** contains valuable research results and is an important scientific achievement in the development of scientific discipline: **Technical Information Technology and Telecommunications** (Informatyka Techniczna i Telekomunikacja).

I believe that this dissertation meets all the requirements for PhD theses and may be the subject of public defence.

I **recommend** the work of Mrs. **Bernadetta Bartosik** for defence.



.....

Dr hab. inż. Aleksandra Kawala-Sterniuk, prof. PO