Skoltech
Skolkovo Institute of Science and Technology

Jury Member Report – Doctor of Philosophy thesis.

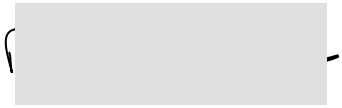
Name of Candidate: Aleksei Shcherbak

PhD Program: Computational and Data Science and Engineering

Title of Thesis: Diagnosis of the human neurological movement disorders based on the analysis of heterogeneous data using ML methods

Supervisor: Associate Professor Andrey Somov

Name of the Reviewer: Roberto Passerone

I confirm the absence of any conflict of interest 	**Date: 05-11-2024**

The purpose of this report is to obtain an independent review from the members of PhD defense Jury before the thesis defense. The members of PhD defense Jury are asked to submit signed copy of the report at least 30 days prior the thesis defense. The Reviewers are asked to bring a copy of the completed report to the thesis defense and to discuss the contents of each report with each other before the thesis defense.

If the reviewers have any queries about the thesis which they wish to raise in advance, please contact the Chair of the Jury.

Reviewer's Report

Reviewers report should contain the following items:

- Brief evaluation of the thesis quality and overall structure of the dissertation.
- The relevance of the topic of dissertation work to its actual content
- The relevance of the methods used in the dissertation
- The scientific significance of the results obtained and their compliance with the international level and current state of the art
- The relevance of the obtained results to applications (if applicable)
- The quality of publications

The summary of issues to be addressed before/during the thesis defense

This thesis considers an interesting and complex diagnosis problem, that encompasses several kinds of neurological disorders. The contributions of the thesis include both the experimental set up, with the development of a synchronization mechanism required to coordinate the data from multiple sensors, and the experimentation with different acquisition methods, as well as the training and evaluation of several machine learning algorithms to get insights into their performance. The candidate experimented with a number of different features, pre-processing the data to extract statistical parameters, filtering to reduce noise, and reducing the overall dimension to retain only the most significant information. The results appear very promising and can be a starting point for a system that assists clinicians in their diagnosis. The methods used in the work have widespread relevance, going from sensing to data processing and understanding, and can be considered at the level of the state of the art. The publications produced by the candidate are extensive, and presented in top rated journals and conferences in the field.

There are at the same time a few points that can be improved.

The account of the related work is very extensive and detailed, and could be taken as a sort of review of the existing technologies. The performance evaluation of the proposed approach is also thorough, and considers the various aspects that might influence performance. Because of this, the candidate is encouraged to make parallels and comparison to the existing work when presenting the proposed techniques. This could help better pinpoint the novelties and the differences, as well as advantages in terms of accuracy and the other metrics that have been used to evaluate the approach. If desired, these considerations could be collected in a discussion section that could be part of the conclusions.

The conclusions, too, could be extended. In particular, the candidate could summarize more precisely the limitations of the techniques adopted in this work, and, more importantly, give a more extensive account of the potential future work that could help overcome them. This would be of help to other researchers, to provide new ideas and perspective.

Finally, the manuscript requires a thorough review of the English language. While the chapters and sections are generally well organized, the grammar and the use of English is at times awkward, making the text sometimes difficult to understand. In particular, the use of the definite (the) and indefinite (a, an) articles, or even when to use them and when not, is very inconsistent (perhaps because these are not used in the candidate's native language). Context helps, but requires an extra step from the reader.

Another suggestion is to add a little bit of context at the beginning of each section, before jumping into the technical details. For instance (but this is true at other points, too), Section 4.1 is empty and is followed immediately by Section 4.1.1. A paragraph introducing what the section is about could help raise the correct expectations.

A few extra suggestions:

Section 3.2:

- Perhaps it would be easier for the reader if the equations (3.1) - (3.7) were placed in the text right after they are mentioned, so that one doesn't have to move continuously in the text to look at the equations.

Section 4:

- Section 4.1.1: the present tense would be more appropriate to describe the method.

- Figure 4.1 is not really described in the text where it appears.

- Section 4.1.3: what is the "exam template"? Do you mean the ground truth? If so, why don't you call it ground truth?
Provisional Recommendation
☒ *I recommend that the candidate should defend the thesis by means of a formal thesis defense*
☐ *I recommend that the candidate should defend the thesis by means of a formal thesis defense only after appropriate changes would be introduced in candidate's thesis according to the recommendations of the present report*
☐ *The thesis is not acceptable and I recommend that the candidate be exempt from the formal thesis defense*