

Doctoral Programme of Computing and Electrical Engineering
EXTERNAL PRE-EXAMINER'S REPORT ON DOCTORAL THESIS

Kindly complete this report and forward it to the Programme by email to cee.doc.tau@tuni.fi within two (2) months' time.

Candidate's particulars

Name of the candidate: Justyna Skibińska

Title of the thesis: MACHINE LEARNING-AIDED MONITORING AND PREDICTION OF RESPIRATORY AND NEURODEGENERATIVE DISEASES USING WEARABLES

Assessment of thesis

(1) General evaluation of the thesis

Please evaluate all items 1-10 and mark clearly just one box in each item.

	<i>Excellent</i>	<i>Very good</i>	<i>Good</i>	<i>Satisfactory</i>	<i>Sufficient</i>	<i>Insufficient</i>
1. Originality	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Clarity of research questions, objectives and conclusions	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Significance of research contribution	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Technological relevance	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Coherence: does the manuscript comprise a coherent unified entity	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. Soundness of research methodology	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. Adequacy and completeness of references	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Logical organization, presentation and language	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Independent contribution considering also the role in co-authored publications	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. Maturity and critical attitude	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

(2) Report on the thesis *(Please use separate sheets, if necessary.)*

Please write here a free-format report of 1-2 pages for summarizing your opinion about the scientific value of the work (the most important results and merits of the dissertation) and the discovered shortcomings. Justify the grades awarded to the individual components in the table above, especially if exceptionally high or low grades are suggested. Minor mistakes and stylistic corrections may be communicated directly to the doctoral candidate, but such suggestions should be noted in the statement.

This thesis is mainly a data-driven research based on existing databases and classification algorithms, specially in the first part, devoted to COVID diagnose. In this case, the main achievement is on the database acquisition, which was not done by the author.

Second part, devoted to Parkinson disease offers stronger contributions. The usage of facial features, emotion recognition, and computational analysis of tongue twister was proved to be successful in PD detection, which is the key novelty and contribution of this thesis.

In summary, the main original contributions of this PhD thesis can be identified as follows:

1. **Development of wearable technology (WHT) and machine learning (ML) applications for healthcare solutions:** The thesis focuses on the application of wearables and ML technologies in the healthcare domain, considering the expanding field of WHT and the need for new solutions in this area. This contribution lies in exploring the potential of wearables and ML for healthcare and developing appropriate technologies in this domain.
2. **Wearable solutions for COVID-19 detection:** The thesis presents practical solutions for COVID-19 detection using ML and wearables. It addresses the need for screening tests in the early stages of the disease and takes into account the contagiousness and incubation period of COVID-19. The developed models show improved accuracy compared to previous approaches in the literature.
3. **Application of ML for Parkinson's disease (PD) detection:** The thesis explores the use of ML methodologies for computerized automatic detection of PD. Two methods are presented: one based on the analysis of changes in facial expressions (specifically hypomimia) and another using a multimodal approach analyzing hypomimia and hand tremors (HD). These methods provide potential alternatives to costly and less accessible tests like PET, MRI, CT, and PSG for PD detection.
4. **Exploration of novel biomarkers and interpretability:** The thesis identifies and analyzes novel biomarkers for disease detection using statistical evaluations and SHAP values. It emphasizes the importance of interpretability in ML models and provides insights into the most informative features for the developed models. This contributes to the understanding and clinical interpretability of the developed support system methodologies.
5. **Extending datasets and future research directions:** The thesis discusses the importance of extending datasets and proposes future research directions. It highlights the need for further exploration of ML methodologies for PD detection based on multimodal approaches and the continued research on COVID-19 detection using wearables and analyzing different types of signals.

Overall, the main original contributions of this thesis include the development and application of wearables and ML technologies for healthcare solutions, the practical solutions for COVID-19 detection, the development of ML-based methods for PD detection, the identification of novel biomarkers, and the emphasis on interpretability and future research directions.

Worth to mention a significant amount of publications in journals and international workshop during the PhD thesis. J. Skibińska has made substantial contributions to the field, focusing on wearable technology, machine learning, and healthcare applications. The publications demonstrate a consistent research trajectory related to the use of wearable devices for health monitoring, including the early diagnosis of COVID-19 and the detection of sleep disorders and Parkinson's disease. These publications indicate a strong foundation for a PhD thesis

(3) Recommendation on thesis pre-examination result

As your overall assessment, place the thesis in one of the following categories by a tick (x) mark.

1. I recommend the permission to publish the thesis.
(Pre-examiner is allowed to suggest minor amendments and minor technical revisions.)
2. I don't recommend the permission to publish the thesis for the reasons set out in my detailed report.

(4) Recommendation for the grade

The faculty council approves and evaluates the dissertation based on the written statements of the opponents, the proposed grade of the possible evaluation board, the pre-examination statements and other written comments.

Doctoral dissertations are graded on a scale of *approved with distinction*, *approved*, and *failed*. For justified reasons, a particularly distinguished dissertation can be awarded the grade 'Approved with distinction'.

My recommendation for the grade:

Approved with distinction

Approved

Failed

Is the dissertation in the international top 10-15% of all dissertations in the field?

Yes

No

Date: July, 2023

Name: Marcos Faúndez Zanuy

Signature:

