Review of Doctoral Thesis

Author: Ing. Tomáš Pokorný
Title: Microwave stroke detection and classification using machine learning algorithms and realistic models of the human head
Reviewer: doc. Ing. Jaroslav Láčík, Ph.D.
Vysoké učení technické v Brně
Technická 12
616 00 Brno

The doctoral thesis deals with the systematic investigation of machine learning algorithms for microwave detection and classification of a brain stroke. Considering the state of the art in the field of the stroke detection, there's no doubt that **the topic of the thesis is topical and it corresponds to the field of biomedical and clinical technology.**

The thesis is written in English and it is structured into five chapters. The first chapter introduces to stroke disease and its diagnostics, describing the state of the art in microwave systems for stroke detection and machine learning algorithms for stroke classification and finally defines the main goal of the dissertation thesis which is „**Systematic testing of the capabilities of machine learning algorithms in the microwave detection and classification of strokes using realistic models of the human head**". In the second chapter, the numerical simulator COMSOL Multiphysics is used to create synthetic training and test data. To validate the simulated data, measured data are used. The third chapter deals with systematic testing of the capabilities of SVM(support vector machine)-based machine learning algorithms in detecting and classifying strokes. The fourth chapter is related to the discussion and the last fifth chapter concludes the thesis.

The most important findings and results of the doctoral thesis are:

- **Single-frequency data of 1 GHz is sufficient for the stroke detection.**
- **Datasets with both transmission and reflection coefficients expressed in real and imaginary parts show higher classification accuracy than datasets with only transmission coefficients or with coefficients expressed in modulus and phase.**
- **Datasets of subjects with smaller strokes appears to be the most suitable for training accurate SVM predictors with high generalization capabilities for stroke-trained position placement.**
- **The SVM algorithm demonstrated an ability to accurately classify ischemic strokes and suggest safe initiation of thrombotic therapy in approximately 70 % of ischemic stroke patients.**

I have a remark and a question to the thesis:

1. In order to increase the clarity of the thesis, the first chapter should have been divided into three separated chapters: introduction, state of the art, aims of the doctoral thesis.
2. The obtained results depend to some extent on the characteristics of the used antenna, its number and location. Do you have an idea how to proceed systematically in choosing an appropriate antenna, its number and location, in order to improve the accuracy of the detection and classification of a stroke?

Considering above facts it is apparent that the main goal of the doctoral thesis was fulfilled. The author used up to date methods. The results of the thesis should be used for further research to improve the sensitivity of the algorithm and increase its clinical usefulness. The relevant topics of the doctoral thesis were sufficiently published in

journals with an impact factor and also in proceedings of international conferences. Formal and language qualities of the thesis are average.

In my opinion, the reviewed thesis met all requirements posed on theses aimed for obtaining PhD degree. **I recommend admitting the doctoral thesis for public defense.**

In Brno, June 5, 2023.

doc. Ing. Jaroslav Lacík, Ph.D.