

Supervisor's opinion on the dissertation thesis

"Noninvasive Localization of the Focus of Ectopic Ventricular Activation"

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Elena Deutsch, MSc. started the Ph.D. study program in full-time form in October 2011, since October 2015 her study was changed to the combined form. She has fulfilled all duties connected with the study program in June 2014 and successfully passed the state exam on June 16, 2015.

The PhD student activities during the study were focused on the possibility of noninvasive assessment of the arrhythmogenic structure or tissue in the heart ventricles where premature ventricular contractions (PVC) are initiated. In this context, first she has studied methods and technologies used for surface recording of cardiac electrical potentials, obtaining the geometry and structure of the patient body and methods for forward and inverse modeling of the cardiac electrical field that could be potentially used for the task. Then, an inverse method based on equivalent dipole generator representing the initial activity in the PVC focus was selected and basic setting of its parameters was proposed and substantiated. Finally, the method was tested in a pilot study on two patients in Ukraine followed by a study on a larger group of patients in Prague. The most laborious and time consuming task was the organization and execution of clinical measurements and processing and evaluation of experimental data that would be not possible without exceptional involvement of the PhD student.

The subject of the research is highly actual and is included as the topic of one of the international working groups around the conference Computing in cardiology dealing with ECG imaging – a rapidly developing area of using several modalities (like ECG, CT, MRI) for noninvasive computerized model-based diagnostics and therapy management of various cardiac diseases. The approach presented in this thesis is one of several methods considered for PVC diagnostics.

The dissertation thesis reflects the PhD student activities and starts with concentrated state of the art in the field followed by specification of the goals of the work. In chapters 3 and 4, detailed proposal of the method for noninvasive PVC focus assessment is presented and basic setting of the experiments is justified. Experimental results presented in chapter 5 allow more detailed adjustment of the method (e.g. evaluation criterion) and input parameters (particular ECG and CT processing) to obtain maximum of correct results. The results are discussed in chapter 6 and conclusions concerning partial results obtained when testing the accuracy and stability of the method are presented in chapter 7. In chapter 8, the achieved results and fulfillment of the goals are summarized.

From my point of view, the main contributions of the thesis are:

- the detailed and well substantiated proposal of a robust method for PVC focus assessment based on inverse solution with dipole equivalent cardiac generator,

- extensive experimental verification of the method and suggestion of optimal input data to achieve maximal number of correct results,
- estimation of the method accuracy and stability in common hospital conditions,
- identification of possible limits and needs for future detailed study of the method.

While some of the results could be expected, other, e.g. better performance of the method when using simplified homogeneous torso model were surprising (and were confirmed by additional experiments on patients in Bratislava).

Until now, the results related to the thesis were published in 7 journal and 15 conference papers; the PhD student was the first author of 5 and 8 papers, respectively. This confirms the fact that the results are also internationally accepted.

During her study and in the submitted thesis Elena Deutsch, MSc. has demonstrated her ability of scientific work and independent solving of research problems. She also showed extraordinary diligence and personal effort necessary for extensive experimental work - data recording in clinical conditions and their variable processing - that was necessary for successful fulfilment of the goals of the PhD thesis. Original results were achieved in the field of biomedical engineering, particularly, a new method for noninvasive PVC focus localization was proposed and experimentally tested on a group of patients. Potential impact of the method in clinical cardiology was also suggested. According to my opinion, with regard to the above mentioned facts, the submitted dissertation thesis is well designed, documents fulfilment of the goals and meets the required standards. I recommend the thesis to be defended, and, upon successful defense, to award Elena Deutsch, MSc. the degree Doctor of Philosophy (Ph.D.).

Bratislava, October 1, 2018.

A large, irregular black redaction mark covering the signature of the professor.

Assoc. prof. Ing. Milan Tyšler, PhD.