



## OPINION

on dissertation work for obtaining  
the scientific degree "Doctor of Science"

Author of the dissertation: **Assoc. Prof. PhD Eng. Galya Nikolova Georgieva-Tsaneva**

Title of the dissertation: **Hybrid approaches for building a digital twin of heart rate variability**

Scientific specialty: **Elements and devices of automation and computing**

Professional field **5.2. Electrical engineering, electronics and automation**

Member of scientific jury: **Prof. DSc Eng. Ivan Stoyanov Yatchev**

### 1. Relevance of the problem developed in the dissertation

The topic of the dissertation is focused at developing a digital twin of autonomous cardiac regulation. Considering the increasing requirements for modern health, sports and IoT systems for continuous and prognostic monitoring of physiological states in real time, it can be said that the dissertation work is dedicated to solving an actual problem.

### 2. Degree of knowledge of the state of the art of the problem

The author has demonstrated a very good knowledge of the problem. A bibliographic reference of 235 sources is presented, all of them in English.

The goal of the dissertation work is developing and study of integrated hybrid methodological framework for processing, analysis, modeling and protection of cardiological signals, based on a combination of classical mathematical and modern AI approaches, supporting the construction of a digital twin of heart rate variability in IoT environments. To achieve this goal, 7 tasks have been posed and solved.

### 3. Scientific and scientific-applied contributions of the dissertation work

Main scientific and scientific-applied contributions:

- A concept for digital twin of heart rate variability is proposed as a customizable and dynamic framework for modeling, interpretation and prediction of autonomic cardiac regulation;
- Original methods for analysis and detection in PPG/ECG signals are proposed, including a hybrid AI approach integrating wavelet representation;

- A regionally adaptive principle for cardiological data protection is formulated, in which cryptographic protection and watermarking protection are adapted to the diagnostic significance of different signal segments;
- Methods and architectures for secure processing of cardiological data have been developed.

#### **4. Evaluation of publications on the dissertation work**

25 publications have been made on the dissertation work, of which 14 are in editions with Impact Factor or Impact Rank, 10 are presented at international and national scientific conferences and 1 is chapter of a monograph. 8 publications are with the dissertation candidate being the only author, and the rest are collective, with the dissertation candidate being in first place in 15 of them. One publication is in Bulgarian (the chapter of a monograph), and the rest are in English.

The minimum national requirements, those of PURPNSZAD of the BAS and the internal rules for the development of the academic staff of the IR have been fulfilled, with group of indicators  $\Gamma$  exceeding the required minimum by more than 4 times, and group of indicators  $\Delta$  exceeding the required minimum by more than 5 times. It should also be noted that there are a number of new citations that are not included in the reference by the dissertation candidate.

#### **5. Critical remarks and recommendations**

It would be good if the list of references was arranged in alphabetical order.

#### **CONCLUSION**

Taking into account the results and contributions obtained in the dissertation, as well as the quantity and quality of the publications to it, I give a **positive** assessment of the dissertation and strongly suggest that **Galya Nikolova Georgieva-Tsaneva** be awarded the scientific degree "Doctor of Science" in the field of higher education 5. Technical sciences, professional field 5.2. Electrical engineering, electronics and automation, scientific specialty "Elements and devices of automation and computing".

Date: 07 June 2026

MEMBER OF THE JURY:

/Prof. DSc I. Yatchev/