

## OPINION

on a dissertation for obtaining an educational and scientific degree „Doctor”  
in the scientific specialty “Application of the principles and methods of cybernetics in various fields  
of science”  
of professional field 5.2 „Electrical engineering, electronics and automation”

Author of the dissertation: **Yordanka Lyubomirova Boneva**

Topic of the dissertation: **Optimization of traffic in urban environment**

Member of the Scientific Jury: **prof. Milena Kirilova Lazarova-Mitseva, PhD,**  
Department “Computer Systems”, Technical University of Sofia

This opinion has been prepared in my capacity as a member of the Scientific Jury, appointed by  
Order №273 / 29.12.2020 of the Director of ICT-BAS.

### 1. General characteristics of the dissertation

The dissertation is composed of introduction, four chapters, conclusion, list of research contributions, lists of publications and citations, list of participations in scientific projects, lists of figures, tables and abbreviations used as well as a bibliographic reference. The dissertation consists of 198 pages and contains 37 figures and 11 tables. The list of the bibliographic references contains 122 publications.

The research object in the dissertation is the optimization of transport traffic in urban environment. The research subject in the dissertation is synchronization and optimization of the road traffic at intersections with time division or light signal regulation. The aim of the dissertation is development of a mathematical model for solving the research problem for optimizing the road traffic in urban transport network. The first chapter discusses the basic concepts of traffic control as well as various models of traffic control in the urban road network. The second chapter presents a bi-level optimization task for traffic control and optimization in urban environment. The third chapter describes the experimental evaluation of the modeling, simulation and optimization of the urban road traffic at selected object of the urban transport network, and the fourth chapter contains a comparative analysis of the experimental evaluation performed.

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

The relevance and the importance of the research problem considered in the dissertation are outlined in its introduction. The adaptive traffic light control as well as the synchronization and the optimization of traffic-controlled road intersections are extremely important issues that allow road congestion in urban environments to be avoided especially in large settlements. The dissertation topic as well as the objectives defined in connection which attract an increased research interest among wide range of scientific groups and researchers.

### **3. Consistency of the used research methodology with the dissertation aim and objectives**

In methodological point of view the dissertation is logically consistent and adequate in respect to the used research methodology which determines the successful accomplishment of the dissertation aim and objectives. The methodology used for the research activities described in the dissertation is based on systematic comparative analysis of the features and the various aspects of the research topic and on that base a reasonable choice of models and tools for solving the research objectives has been made. The proposed, developed and evaluated mathematical, computer and simulation models are based on reasoned selection, theoretical justification, experimental evaluation and verification of their application and utilization.

### **4. Scientific and scientifically-applied contributions of the dissertation work**

I fully agree with the author's formulation of the contributions achieved as a result of the research presented in the dissertation. The contributions can be referred to the categories of enrichment of existing scientific knowledge and scientific achievements in practice as well as creation of new and modification of existing models for solving the research objectives of the dissertation. Based on the results obtained in the dissertation the contributions can be systematized as follows:

- A mathematical model of a research object urban road network regulated by traffic light signaling has been suggested. The model allows analytical and numerical simulations to be performed in order to optimize a traffic lights system;
- A new mathematical model is suggested for optimization of urban traffic through two hierarchically connected tasks. The model allows the optimal values of a larger number of control variables to be determined: cycle and duration of green light of a system of crossroads;
- The light signaling of traffic lights and the duration of the cycle have been optimized by applying the suggested hierarchical model for optimization. The results of the numerical evaluation of the optimization confirm its applicability to obtain real-time solutions and to adapt the traffic light system management according to the traffic dynamics;
- A simulation computer model of a network of crossroads has been suggested which allows additional conditions in traffic control to be taken into account such as presence of a tram line and parking permit in a system of transport crossroads;
- An experimental evaluation of the results of analytical optimization is made based on the application of the suggested bi-level optimization model and the simulation results of the suggested computer model which clearly demonstrates the advantage of the bi-level optimization model in real-time traffic road control in comparison with the simulation results.

### **5. Evaluation of the author's publications on the dissertation's topic**

The scientific results and research contributions in the dissertation have been published in 5 scientific papers: three of the papers are presented at national and international research conferences and two papers are published in scientific journals. Four of the publications are single-authored. Two of the publications are indexed in Scopus.



The publications are made in the period from 2018 to 2020. The papers cover the research topics of the presented dissertation and comprise the results and the contributions achieved. One of the publications has two citations. Two of the author's publications are awarded a best paper award in the relevant sections of the scientific conferences at which they are presented.

## **6. Critical notes on the dissertation**

The dissertation reveals a large amount of research done by its author. The dissertation has been carefully prepared at a high scientific level of presentation of the research topic and shows the author's research comprehension on the topics addressed. I would recommend the author to continue her research on the research topics addressed in the dissertation and to target her scientific activities to practical utilization of the suggested and developed models in order to achieve applied results in practice.

## **7. Conclusion**

Based on the above said, I consider the dissertation as fully corresponding to Act on the Academic Staff Development in Republic of Bulgaria, the Regulations governing the application of the Act and the Regulations for the application of the Act in the Institute of Information and Communication Technologies at the Bulgarian Academy of Sciences as well as the minimum requirements for obtaining the educational and scientific degree "Doctor" which are fulfilled with significant excess. The dissertation is related to a relevant scientific area which has been highly targeted by considerable research efforts. The author has accomplished the dissertation aim and objectives. The obtained research contributions are significant for both science and practice and are achieved by the applicant herself. The contributions reached as a results of the dissertation studies are presented in numerous research papers that have been published in scientific journals and presented at national and international scientific conferences thus making the dissertation results and the contributions available to the international scientific community.

Therefore I am convinced of my positive assessment of the presented dissertation and propose to the honorable members of the Scientific Jury Yordanka Lyubomirova Boneva to be awarded the educational and scientific degree "Doctor" in the scientific specialty „Application of the principles and methods of cybernetics in various fields of science" of the professional field 5.2 Electrical engineering, electronics and automation.

Date: 19.02.2021

Member of the Scientific Jury:

**NOT FOR  
PUBLIC RELEASE**

/ prof. Milena Kirilova Lazarova-Mitseva, PhD /