

REVIEW

About dissertation thesis of Mag. eng. Yordanka Lyubomirova Boneva with title „Optimization of traffic in urban environment” presented for the acquisition of educational and scientific degree “doctor” in a doctoral program “Application of the principles and methods of cybernetics in various fields of science”, professional field: 5.2. „Electrical engineering, Electronics and Automation “.

Reviewer: Prof. eng. Kosta Petrov Boshnakov, PhD, University of Chemical Technology and Metallurgy, Sofia

1. Topic and relevance of the dissertation

The topic of the dissertation presented for review to me is "Optimization of traffic in urban environment". The aim is to develop a mathematical model for solving a research problem for optimizing road traffic in urban transport network. A network of four connected, light-regulated intersections, located on Shipchenski Prohod Boulevard in Sofia, Bulgaria, was chosen as object of the study. To achieve this aim, six tasks have been formulated.

The relevance of the developed topic of the dissertation is not in doubt. With the increase of the population of the cities, the change of the way of life of the inhabitants and the available road infrastructure, the oversaturation of certain road sections are typical phenomena, which besides the sharp decrease of the average speed of movement is connected with the increase of fuel consumption and increase of the harmful emissions. Research and finding optimal solutions for urban traffic management can lead to a reduction of its negative consequences with reasonable investments.

2. Review of the cited literature

In the dissertation project 122 scientific sources are cited. Of these, 103 are in Latin and 19 are in Cyrillic. References to literature sources are found mainly in the first and second chapters, which have a review character. I think that the PhD student is well grounded in modern scientific achievements of the dissertation’s subject area.

3. Review of the dissertation and analysis of the results

Chapter 1 is entitled "Transport traffic management models" and has an overview and introductory nature. The main terms used in the dissertation are introduced. Models of traffic flow for the main transport network (Cell transmission, Store-and-forward and Dispersion-and-store) are presented and the conditions for which they are suitable are analyzed. The possibilities for traffic management and the strategies for its management in real time are considered.

Chapter 2 provides an analysis of hierarchical optimization problems and models. The Store-and-forward model is presented mathematically. The optimization criteria are considered and management strategies are analyzed. The problem for bilevel optimization for urban transport

network management is presented and a comparison is made with the classical optimization problem.

Chapter 3, entitled "Development of hierarchical models for optimizing transport traffic" contains the main research results obtained in the dissertation. Brief descriptions of the Aimsun simulation environment and the TRANSYT 15 traffic light control optimization software environment are presented. Software tools like MATLAB and YALMIP are used for realizing the bilevel optimization.

A description of the selected object of study is done, which includes four connected light-regulated intersections along Shipchenski Prohod Blvd. in Sofia. A number of simulation studies have been conducted: The settings of the green signal for the traffic lights on the boulevard and the small streets crossing the boulevard are changed, using 10 indicators to assess whether there is an improvement or deterioration of traffic;

For the selected target network, the light signaling of traffic lights was optimized using the software products Aimsun and TRANSYT. Improvement is measured by eleven traffic indicators.

Different instruments for the realization of the dissertation's goals are applied. Bilevel optimization and the Store-and-forward model for optimization of the transport network are applied. MATLAB software products with the additional modeling and optimization tool - YALMIP and Aimsun are included. A graphic model of the considered urban network is attached.

The cycle length is optimized by bilevel optimization. The Store-and-forward model in a bilevel optimization problem has been formalized. The aim of the study is to reveal the potential of bilevel optimization for the cycle length in a network of intersections.

The influence of the presence of tram stops and street parking on the traffic was studied. It has been proven that tram stops do not significantly affect traffic performance and environmental pollution. The presence of on-street parked cars has a significantly more negative impact.

Actuated control of traffic light signaling and its influence on fuel consumption and air pollution has been studied. Its advantage over the application of fixed time signal timing has been demonstrated.

Chapter 4 is entitled "Simulation and numerical experiments and results". It compares the results of the simulation studies in Chapter 3. The results of the following simulation experiments are considered: real data experiment, green traffic light optimization, cycle optimization and TRANSYT optimization. In most cases, TRANSYT gives the best results. In three of the indicators, the bilevel optimization of the green signal has an advantage over TRANSYT - flow, speed and number of stops.

The dissertation ends with: conclusion - summary of the obtained results, contributions of the dissertation, future development, publications, citations, participation in projects, declaration of originality of the results and bibliography.

4. Contributions of the dissertation

1. A mathematical model of an urban road network regulated with traffic light signaling has been modeled for the purpose of simulation research and traffic optimization.
2. Simulation studies were performed on the influence of the green signal settings of traffic lights.
3. Optimization of the light signaling of traffic lights and the cycle length by bilevel optimization has been made.
4. The influence of the presence of tram stops and street parking to the traffic and actuated control of the traffic light signaling has been studied.
5. The results of the simulation experiments for the cases with real data, optimization of the green traffic light, optimization of the cycle and optimization with TRANSYT are analyzed.
6. The results obtained using the bilevel optimization of the green signal and the results of the software product TRANSYT are compared.

5. Opinions about the dissertation's publications on the topic of the dissertation

The dissertation is accompanied by a list of five scientific papers, four of which are independent and one is with the supervisor. Four of them are in English and one is in Bulgarian. Two of the publications on the topic of the dissertation are indexed in Scopus. They are published respectively in CompSysTech'20: ACM International Conference Proceeding Series, Ruse, June 2020 and IOP Conference Series: Materials Science and Engineering, 2020. The first of them is an excellent report in the respective session and was awarded with crystal award. One publication is in the Journal "Information Technologies and Control", 2019, one in the Proceedings of the International Conference Automatics and Informatics'2019 and one in the scientific journal "Mechanics Transport Communications", 2018. There are two citations of the last publication. The citations are in editions indexed in Scopus.

6. Comments, questions and remarks

I have no significant remarks on the dissertation. I believe that the dissertation would win if the object of study is presented with a block diagram in terms of the theory of automation control and for each study its control, disturbance and target variables are formulated.

7. Assessment of the correspondence between the abstract and the dissertation

The abstract has a volume of 51 pages. At the beginning of the abstract a general description of the dissertation is made, which includes relevance of the problem, object and areas of research, content of the dissertation by chapters, purpose and tasks of the dissertation, approbation of the dissertation, list of dissertation publications, citations and participation in projects. The following is an abbreviated description of the content of chapters 1 to 4 of the dissertation, conclusion, scientifically-applied and applied contributions, future development, acknowledgements, literature and declaration of originality of the results. I confirm that the presented abstract corresponds to the dissertation and fully reflects the performed experiments and research.

8. Personal impressions about the dissertation

I do not know Mag. eng. Yordanka Lyubomirova Boneva. My only positive impressions are from the preliminary defense of her dissertation.

9. Conclusion

According to the IICT Regulations for the specific conditions for acquiring scientific degrees and for holding academic positions for the educational scientific degree "Doctor" for professional field 5.2. Electrical engineering, electronics and automation, the minimum requirements are to achieve 50 points on the group of indicators A and on G - 30 points. In the group of indicators A, 50 points are achieved with the presence of a dissertation for the award of educational and scientific degree "Doctor". With the attached scientific papers the doctoral student has achieved 130 points in the group of indicators G and in that manner she exceeds many times the minimum requirements.

In addition to the requirements, the following results have been achieved: In one of the articles, two citations were noticed in editions indexed in SCOPUS, which brings the group of indicators D 20 points. Except this, there are two participations in National research projects, which brings the group of indicators E 20 points.

I think that the presented by Mag. eng. Yordanka Lyubomirova Boneva dissertation thesis has been written on a good scientific level, five publications have been made on its subject matter and there are a sufficient number of scientifically-applied and applied contributions. The requirements of the Law on the Development of the Academic Staff in the republic of Bulgaria, the Rules on the specific conditions for acquiring academic degrees and for occupying academic positions and the Rules of IICT-BAS have been accomplished.

The review gives me the reason to propose to the honourable Scientific Jury to award Mag. eng. Yordanka Lyubomirova Boneva the educational and scientific degree "Doctor" in Doctoral Program "Application of the principles and methods of cybernetics in various fields of science", professional field: 5.2. „Electrical engineering, Electronics and Automation“.

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PUBLIC RELEASE**

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prof. eng. Kosta Boshnakov, PhD