OPINION

From D.Sc. Krasimira Petrova Stoilova

Institute of Information and Communication Technologies –
Bulgarian Academy of Sciences,

about the PhD thesis for acquisition of the scientific degree "doctor"
in the professional area 5.2 Electrical Engineering, Electronics and Automation,
PhD program "Application of the principles of cybernetics in various fields of science"

Author of the PhD thesis: **Rosen Simeonov Petrov**

Topic of the PhD thesis: **Information and communication technologies for smart homes**

Ph.D. Supervisor: prof. PhD Dimitar Karastoyanov, IICT-BAS

1. Actuality of the dissertation's problem

Intelligent solutions are applied in various fields of the modern world and one of them is the so-called "smart" homes, which are the subject of the dissertation. The purpose of their creation is to provide consumers with an efficient environment and at the same time to minimize the cost of facilities and installations. Intelligent buildings are an interdisciplinary object that requires knowledge from various fields: architecture, design, facades, sound insulation, building automation (air conditioning, heating, water supply, sewerage, electrification, monitoring, etc.), use and maintenance, information and communication technologies, sensors, automation and control of different types of applied systems in them. Among these technologies, the role of information technology is essential, which is a key element of the overall system "smart home". I believe that the topic of dissertation research is extremely relevant against the background of the increasingly difficult supply of vital energy resources worldwide. The doctoral student demonstrates a very good knowledge of the state of the problem and cites practices from different countries around the world, both from the European Union and from China, Japan, Britain, Saudi Arabia, Korea and others. The goals and tasks of the dissertation are formulated on page 15: **"The aim of the dissertation is to study the progress and integration of new technologies in modern construction to reduce operating costs and improve quality of life and to propose an innovative approach to creating a smart home.**

To achieve this goal, the following tasks must be solved:

1. To make a detailed overview, analysis and systematization of approaches and methods for integration of intelligent technologies in the creation of smart buildings.
2. To explore problems and modern solutions for building smart homes.
3. To study the impact of buildings on climate and the contribution of intelligent technologies to combating climate change.
4. To propose innovative solutions for improvement and integration of smart technologies for residential buildings.
5. To propose and substantiate an innovative model for creating a smart home equipped with intelligent technologies. The obtained results will be analyzed.
6. Conduct experiments to compare modern and innovative methods of building smart homes used to improve the quality of life of residents. "

A complete correspondence has been achieved between the set goal and tasks of the dissertation, the chosen research methodology and the achieved contributions.

2. General characteristics of the dissertation

The dissertation, presented on 110 pages, is structured in 4 chapters, conclusion, contributions, list of publications on the dissertation, bibliography and declaration of originality. 70 contemporary literature sources have been used, most of them from the last 15 years.

The first chapter provides an overview, analysis and systematization of different types of information and communication systems for smart homes *in implementation of Task 1* of the objectives. Different definitions of smart homes from different world sources are presented. The main approaches for defining intelligent buildings are given: Approach based on the operation of the building; a service-based approach that the building is able to offer; System based services. The research in the dissertation combines all three approaches in creating the model for a smart home, which is a strong positive side from the point of view of systems engineering.

The second chapter examines the problems and modern solutions for building smart homes *in implementation of Task 2* of the objectives. The characteristics of building automation systems are presented, including programming and monitoring platforms and the environment; communication networks; communication standards in building automation systems; internet technologies and their applications for building automation systems.

The third chapter proposes innovative solutions for the improvement and integration of smart technologies for residential buildings *in implementation of Task 4* of the objectives. Basic technologies for building an intelligent home are presented; key smart home equipment; the necessary communication system; some exterior solutions and an innovative scheme of a "smart" home with smart appliances and systems.

In the **fourth chapter** a model of a single-family house with built-in intelligent management systems is created according to the current norms *in implementation of Tasks 3 and 5* of the set goals. The synthesized model is compared with a system without energy management and an analysis of the obtained results is done *in the implementation of Task 6* of the objectives.

3. Characteristics and evaluation of the contributions to the dissertation

The research in the dissertation is focused on management systems in residential buildings as an element of building automation. The peculiarity here is that it is necessary to take into account and integrate a number of areas such as architectural design, use of energy efficient building materials, accounting for heating and lighting requirements of the home, air conditioning, water supply and sewerage systems, smart home service systems (maintenance, monitoring, analysis and control of electricity consumption), security systems, monitoring and control systems, accident warning systems, compliance with a number of communication protocols and modern information technologies, including web services. Both interior and exterior solutions for building a modern smart home are taken into account. All these areas and technologies with the relevant requirements, standards, protocols, norms in line with the European Green Pact for more efficient use of resources by moving to a clean, circular economy and stopping climate change are included in the subsystems that make up the system for smart home management. The PhD student has managed to analyze, summarize and integrate not only the modern information and communication technologies needed for building automation, but also the other subsystems that make up the smart home management system. There is a correspondence of the chosen research methodology with the set goal and tasks of the dissertation. I believe that the doctoral student has successfully coped with the goals and objectives of the dissertation and I evaluate the positive results as scientific and applied:

1. An innovative approach to building a smart home has been developed by integrating three approaches: an approach based on the operation of the building; an approach based on the services that the building can offer and system based services.

2. An analysis of modern technologies needed to build a smart home has been made and innovative solutions have been proposed to improve the comfort of residents and at the same time environmentally friendly.

3. A model of a smart home management system based on modern regulations has been synthesized. The model provides innovative solutions for the integration of smart technologies for residential buildings while at the same time in harmony with nature and complies with the requirements for reduced environmental pollution, use of energy-independent sources, utilization of rainwater and wastewater.

4. An analysis of the energy efficiency of the synthesized model is made on the basis of a comparison of energy costs in the presence and absence of a management system with a proven advantage of the developed model.

5. The received research solutions have aroused the interest of a company, which has expressed readiness to implement them in its practical work, which I evaluate as an indisputable applied result of the research.

4. Publications of the dissertation on the topic of the dissertation

The dissertation is based on 6 scientific publications, one of which is in a journal and 5 are from conference proceedings. One of the publications is independent [3], and in the other three the doctoral student is in first place [1], [4], [5]. This gives me reason to conclude that they are all prepared by the doctoral student. Publications have been reviewed by at least two independent reviewers. The publication of results on all tasks set to achieve the goal of the dissertation makes a good impression.

The minimum requirements for publication activities for obtaining the educational and scientific degree "Doctor" according to the Laws of Bulgaria in this domain are 30 points. The doctoral student exceeds twice the minimum requirements of the Regulations for the specific conditions for acquiring scientific degrees and holding academic positions at IICT-BAS.

His publications refer to section "Г8 Publications in unreferred journals with scientific review or in edited collective volumes" and have the following weight: [1] 20/2 = 10 points; [2] 20/3 = 6.66 points; [3] 20 points; [4] 20/2 = 10 points; [5] 20/3 = 6.66 points; [6] 20/3 = 6.66 points or he has a total of 60 points. The results related to the dissertation have become known to the international scientific community.

5. Correspondence between the abstract of the thesis and the thesis

The abstract of 29 pages in Bulgarian and 27 pages in English reflects the research, main results and contributions of the dissertation.

6. Use of the obtained results

In the attached documents to the dissertation there is a Declaration from the company "Martmax" Ltd., which declares interest in the innovative model developed by the dissertation, which model the company will use for design and implementation of single and multifamily residential buildings.

I believe that the stated interest of the company is a very good certificate for the work done by the dissertation, whose research results have not remained only in the middle of the academic community, but are useful for practical developments.

7. Critical remarks end comments

1) No reference has been attached for fulfillment of the minimum requirements for awarding edicational and scientific degree "PhD" pursuant to Article 6 (1) of the Regulations on the specific conditions for acquiring scientific degrees and holding academic positions at IICT-BAS.

2) The conclusion of the Dissertation is not in accordance with the academic requirements.

3) In the dissertation syntactic, grammatical and technical errors were made, as well as those in the numbering (of figures, of cited sources). Some omissions:

- The author's abstract does not cite the sources in the names of the figures.

- In the Dissertation p.81 is written "The research in Chapter 3 is in accordance with task 3 of the Objectives of the Dissertation" instead of "... task 4 of the Objectives ...".

- P. 100 - instead of "The research in this chapter is in accordance with task 4 of the objectives of the Dissertation", it should be "... tasks 5 and 6 of the objectives ..."

- In Chapter 4, after Fig. 1.3, a new numbering 4.1, 4.2, etc. follows.

- In the dissertation there is no correspondence between the exposition and cited sources: page 85 before Fig. 4.1 is cited a source [61], which does not correspond to the reference; p.59 and [48]; p.76 and [54]; p.78 and [55]; p.86 and [63]; p. 87 and [54]; p.91 and [64]; p. 92 and [50]; p. 92 and [65]; p. 93 and [66]; p. 94 and [67]; p. 96 and [68]; p. 98 and [69] et al.

- Inaccuracies: page 99 - instead of "Based on the model presented in the previous chapters", it should be written "... in this chapter model".

Inaccuracies do not diminish the contributions of the dissertation, but the author should be more precise in publishing his future results.

Questions:

1. What are the intelligent functionalities of the created model in Chapter 4, according to the approaches for building intelligent homes, set out on page 4 of the Dissertation, including the used internet communication protocols? How information technologies at the management level are used in the model? They should be summarized in the Conclusion of the dissertation.

2. How will the author comment on the expression from page 98 - "maximum optimization"?

8. Conclusion

The dissertation of Mag. Eng. Rosen Petrov meets the conditions of Act of Development of the Academic Personnel of the Republic of Bulgaria, RAADAPRB and the Regulations for the specific conditions in IICT-BAS. The dissertation contains scientific and applied results that are innovative in nature, which I appreciate **positively**. The candidate has knowledge in a number of areas (information and communication technologies, building automation, design and engineering, heating and ventilation systems, control systems) and demonstrates the ability for independent research. I consider the dissertation's contributions to be significant for the practice.

I strongly recommend to the Honorable Scientific Jury the awarding of the educational and scientific degree "Doctor" to Mag. Eng. Rosen Simeonov Petrov in the field of higher education Technical sciences, professional field 5.2. Electrical Engineering, Electronics and Automation in the doctoral program "Application of the principles and methods of cybernetics in various fields of science."

На основание
331 А

10 March 2022

Member of the Jury: