

## REVIEW

by Acad. Ivan P. Popchev – BAS

of dissertation work for acquiring the educational and scientific degree

„Doctor“

In professional direction 4.6 „Informatics and Computer Science“

Doctoral program „Informatics“

Titled „Integration of heterogeneous data from distributed IoT devices“

by Kristina Ivanova Dineva

By Order № 211/02.11.2020 of the Prof. G. Angelova, DSc – Director of IICT - BAS in accordance with Art. 4, para. 2 of the Act of Development of the Academic Personnel of the Republic of Bulgaria (ADAPRB) and with the decision of the Academic Council of IICT (rec. of proceedings № 10 from 30.19.2020 г.) for awarding of educational and scientific degree “doctor” in professional direction 4.6 „Informatics and Computer Science“, doctoral program „Informatics“ by Kristina Ivanova Dineva of dissertation work titled „Integration of heterogeneous data from distributed IoT devices“ I have been appointed as a member of the Scientific Panel.

When assessing the dissertation work, the terms ADAPRB, RAADAPRB (Decree № 26 of 13 February 2019) and the Rules for specific requirements of IICT-BAS for the application of the law and therefore will be accurately delivered:

1. According to Art. 27 (1) of ADAPRB “the dissertation work shall contain scientific or applied research results that represent an original contribution to science. The dissertation shall show that the candidate has profound theoretical knowledge in the respective subject, as well as their abilities of independent scientific research.”
2. According to Art. 27 (2) of ADAPRB “the dissertation work should be presented in a form and volume corresponding to the specific requirements of the primary unit. The dissertation work should contain title page; contents; introduction; presentation; conclusion - summary of the obtained results, accompanied by a declaration of originality; bibliography.”

According to RAADAPRB, the minimum required number of points by groups of indicators for "Doctor" are:-

Group of indicators	Contents	Number of points
A	Indicator 1	50
G	Sum of indicators from 5 to 10	30

The scientific supervisor of the dissertation is assoc. **Prof. Tatiana Atanasova, PhD.**

The **aim** of the dissertation is formulated on page 26 and it is " to develop a system and tools for processing, modelling and integration of heterogeneous data obtained by distributed IoT devices ".

The **following five tasks** are defined:

1. To propose a methodology for processing, modelling and integration of heterogeneous data obtained from distributed IoT devices.
2. To develop a modular hardware system architecture and to design an appropriate method for communication between distributed IoT devices.
3. To propose an architecture of a software platform and an approach for the organization of the services for the intelligent processing of heterogeneous data from an IoT system.
4. To construct valid machine learning models for experimental validation of the proposed methodology.
5. To provide a possible application in intelligent agriculture of the proposed system and tools for the integration of heterogeneous data obtained from IoT distributed devices.

The dissertation consists of totally 166 pages, 55 figures, 16 tables, 175 references and it includes:

- Glossary of terms and abbreviations used in the dissertation (4-5);
- Introduction (6-7);
- Analysis of the state of study (**Chapter 1**, 8-26);
- Methodology for processing and integration of heterogeneous data (**Chapter 2**, 27-64);
- Modular IoT system architecture (**Chapter 3**, 65-102);
- Experimental Results (**Chapter 4**, 103-129);
- Practical application of the developed IoT system (**Chapter 5**, 130-141);

- Conclusion and summary of the received results (143-144);
- Guidelines for future research (144);
- Publications on the dissertation topic (145);
- Known citations (146-147);
- Declaration of results originality (148);
- Acknowledgements (149);
- Bibliography (150-161);
- Applications (162-166).

**12 publications on the topic of the dissertation** are presented.

The **analysis** of these publications briefly shows the following:

- 6 publications are in SJR editions (NNº 1, 2, 4, 5, 7 and 8);
- 2 publications have a Scopus index (NNº 3 and 10);
- 3 publications are in Bulgarian (NNº 6, 11 and 12);
- 2 publications are independent (NNº 11 and 12);

**19 citations of 8 publications** are known.

Publication Nº 8 has the largest number of citations - a total of 7.

The doctoral student holds the **IICT-BAS award** for excellent scientific achievements in 2019 in the category "Doctoral students".

**The requirements** of the RAADAPRB and specific requirements of IICT – BAS are fulfilled.

In a brief analysis, the reviewer proposes a separation of the "traditional" citation only as a "square bracket" of a particular publication, and keep the focus on **the dissertation of Antonio Rafael Braga, Fortaleza, 2020** on page 43 **Tabela 1 - Resumo dos trabalhos relacionados**, where the solutions of many researchers starting from 1996 till 2019 are presented, incl. DINEVA; ATANASOVA 2018a, and for which a comparison was made based on five criteria, such as: I -; IoT - V; IoT + E - V; AM - V; I + IoT + E + AM -. This inclusion in the „Tabela“ deserves **attention**.

Publications NNº 7 and 8 are cited on page 112 of the dissertation.

On pages 143-144 in "Conclusion - summary of the received results" are formulated **five applied scientific contributions**.

According to Art. 6 (3) of ADAPRB „The dissertation paper must contain scientific or applied scientific results, being an original contribution to science...“. This predetermines the **author's self-assessment** of the results.

The obtained **results** briefly can be systematized as follows:

1. An IoT system architecture containing sensor, control and communication modules is proposed.
2. A method has been created for the communication between devices and a modular IoT hardware system using hierarchical IP addresses based on the proposed "Snowflake" logical scheme.
3. Machine learning models are proposed and implemented which are then integrated into MSA (Microservice architecture) software architecture.
4. The possible application of the developed modular IoT system is shown in the beekeeping where it is compared with 5 other similar systems and the economic efficiency and expediency is proved.
5. Guidelines for future research are provided.

**Critical notes:**

1. In the bibliography, individual sources are given incompletely with undescribed ISSN/ISBN, publication year, publisher, pages, etc.
2. Publications on various pages are presented incorrectly. For example, on page 145, publication № 12 is in Bulgarian, and as publication № III of the noted citations is in English on page 146. The same differences can be seen for NN№ 11 and 12 in Bulgarian on page 145, and page 102 and page 142 they are in English, as well as in the bibliography on page 153.
3. In the Reference for the fulfilment of the minimum requirements, SJR in 5 publications has a different value from the respective values in the publications on the topic of the dissertation (p. 145).
4. Publication № 6 is missing in the bibliography.
5. In the abstracts, the publications NN№ 11 and 12 are in English.

**Questions on the dissertation work:**

1. It is written on page 129 that "determining the most directly dependent variables on the subject of the task in question increases...". Can a few examples be provided which are considered as "the most directly dependent variables" to the realized tasks? What are the criteria for measuring the accuracy and precision of the model?
2. Page 130 states that "one of the many practical applications of the proposed modular IoT system is shown". What are the "many practical applications" and what could be their future application?
3. In Table 5.1, how are the calculations done for price per hive per device and monthly subscription to the platform?

4. Why the following is missing in the proposed Smart Bee Hives system: bee counter and ERP? How is self-analysis performed in this system? How is monitored the "condition of their hives - through understandable diagrams".
5. Why "High value" is not considered as the combination of a low price and high quality and why this is considered as the "golden mean"? How do the fluctuations the market price affect everything else?
6. Is it possible to share what is meant by (p. 144) "system security research" and "integration of automated security systems"?
7. What does "improving the life cycle" mean in this context (p. 144)?
8. Define at what time, by what team and with what financial resources "guidelines for future research" can be implemented? Can these four guidelines be ranked in some priority over time?

A generalized "**scientific-metric profile**" of the doctoral student Kristina Dineva can be built on data taken from the world scientific databases:

- Scopus: 9 documents by author, 11 citations, h-index 2;
- Web of Science: 2 publications, 0 sums of times cited, h-index 0;
- Scholar.google: 28 citations, h-index 3; i10-index 0;
- Researchgate: RG Score 1.97, 16 citations, h-index 2 excluding self-citations.

The generalized "**scientific-metric profile**" deserves to be a subject of a careful and critical **self-analysis**, to form future research and to present sufficient grounds for independent publishing activity in publications with IF/SJR.

**The Abstracts** are in Bulgarian and English, respectively including totally of 36 and 33 pages and present the dissertation.

#### **CONCLUSION**

The dissertation work fulfils the requirements of ADAPRB, RAADAPRB and the specific requirements in IICT – BAS.

I give a **positive conclusion** for acquiring the educational and scientific degree "**Doctor**" to Kristina Ivanova Dineva.

I propose to the Scientific Panel to unanimously vote for Kristina Ivanova Dineva the educational and scientific degree "**Doctor**" on 4.6. "**Informatics and computer sciences, doctoral program "Informatics"**".

18.11.2020