

REVIEW

From Prof. Radoslav Yoshinov PhD

on a dissertation for obtaining an educational and scientific degree "Doctor" with author mag. Kristina Ivanova Dineva on the topic "INTEGRATION OF HETEROGENEOUS DATA FROM DISTRIBUTED IoT DEVICES" under the scientific guidance of Assoc. Prof. Dr. Tatiana Atanasova in professional field 4.6 "Informatics and Computer Science", specialty "Informatics"

1. Relevance of the dissertation

In the paradigm of "Internet of Things" (IoT), the processing of data acquired by IoT devices can be separated as a separate academic discipline aimed at developing and upgrading methods and tools that are important for increasing productivity, competitiveness of production and quality of life. IoT devices are physical systems, many of which are security-related. Therefore, the compromise of such devices can lead to physical damage to persons and property, even death. Therefore, the object of IoT security is not the application of a single, static set of metaprotection rules, as they apply to network devices and hosts. This requires a unique application for each system and system of systems in which Internet devices participate. IoT devices have many different variants, but the collective IoT device has almost any of the following properties:

- Manipulates or monitors something physical (in the device or the environment or the environment of the device), ie. the work itself or a direct connection to something;
- Ability to communicate directly or indirectly via the Internet:

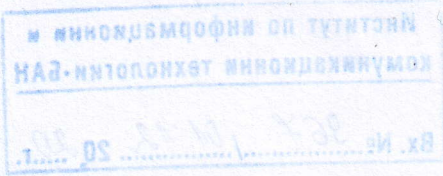
The relevance of the present dissertation, analyzing methods and means for integration, processing and modeling of heterogeneous data obtained from distributed IoT devices, immediately stands out.

2. Degree of knowledge of the state of the problem and general characteristics of the work

In the dissertation an in - depth review analysis of the achievements in the field of methods and means for integration, processing and modeling of heterogeneous data obtained from distributed IoT devices is performed.

The dissertation is structured in five chapters.

In the first chapter an analytical review of the theoretical basis related to the problem area of the dissertation is made. The need to expand the upgrade and



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improve the existing methodology for working with heterogeneous data is motivated.

Chapter two presents a systematized methodology for processing, modeling and integration of heterogeneous data extracted from IoT devices. A general conceptual scheme of development is presented, including a theoretical methodological framework, as steps grouped in four main stages, based on an overview and comparative analysis and systematization of existing methods and approaches.

Chapter three describes the process of developing an IoT platform architecture, consisting of hardware and software interconnected systems that communicate with each other.

In the fourth chapter an experimental realization and validation of the developed methodology and creation of validated ready models for machine learning for integration in a real environment is made.

The fifth chapter presents a practical application of the created system.

The Conclusion presents a summary of the results obtained from the development.

Guidelines for future research and development have been identified. A list of scientific publications on the topic and noted citations is presented.

The bibliography of the dissertation cites 175 literary sources: books, scientific articles and Internet publications. Based on the review analysis, the doctoral student formulates the goal and tasks of the dissertation.

General characteristics of the dissertation include - Glossary of terms and abbreviations used in the dissertation, introduction, five chapters, conclusion, contributions, guidelines for future research, publications on the topic of the dissertation, noted citations, declaration of originality, scientific papers of the doctoral student related to the dissertation, used literature. The dissertation contains 166 pages, 55 figures, 16 tables and 175 literature sources.

This proves that the doctoral student has in-depth knowledge in the subject of the research.

3. Correspondence of the proposed research methodology and the set goals and objectives of the dissertation

The aim of the dissertation is to offer a system and tools for integration of heterogeneous data from distributed IoT devices, which allow their processing, modeling and integration.

For this purpose, the following tasks are defined:

1. To propose a methodology for processing, modeling and integration of heterogeneous data from distributed IoT devices.

2. To propose an architecture and method for communication of a modular IoT hardware system.

3. To propose an architecture of a software platform and an approach for the organization of services for intelligent processing of heterogeneous data from an IoT system.

4. To create valid models for machine learning for experimental confirmation of the developed methodology.

5. To show a possible application of the IoT system and the tools for integration of heterogeneous data from distributed devices in intelligent agriculture. The doctoral student has formulated five tasks, through the solution of which to achieve the set goal.

The development has interesting summaries and guidelines for future development.

The chosen methods correspond to the main goal and tasks set for solving by the doctoral student.

4. Characteristics of the nature and assessment of the reliability of the material on which the contributions of the dissertation are built

The methods and models that are created and used in correspondance to the target task. Some, empirical numerical results have been obtained, while for others, solutions have been presented and guidelines for future research have been provided. I have not noticed any errors in either the concrete or the conceptual models. I also find that the proposed strategies are well-founded.

5. Contributions to the dissertation

The contributions are described in the chapter Conclusion - summary of the results obtained.

The more significant results obtained in the dissertation are summarized in the author's claims for five scientific and applied contributions:

1. A methodology for integration of heterogeneous data acquired from distributed IoT devices has been developed, which allows processing, modeling and integration of this data, by selecting and selecting:

- methods for working with heterogeneous data;
- classification and regression algorithms for machine learning;
- metrics for evaluation and validation of obtained forecast results.

2. An architecture of a modular hardware IoT system has been developed, consisting of sensor, control and communication modules. A new method for communication between IoT devices has been developed, based on hierarchical IP addressing with the proposed "Snowflake" grouping logic.

3. MSA software architecture for storage, processing and analysis of heterogeneous data has been designed and implemented. A new approach to the organization of services for intelligent data processing and exchange in the IoT system has been developed, which increases the reliability of the system operation.

4. Models for machine learning have been created, which experimentally confirm the developed methodology and are integrated in the implemented MSA software architecture.

5. Possible application of the developed IoT system for integration of heterogeneous data in intelligent agriculture is shown. A comparative analysis of the functional characteristics and market positioning of existing similar systems is made, through which the economic efficiency and expediency of the developed IoT system is proved.

The reviewer accepts scientific and applied contributions (1,2,3,4).

The fifth contribution is a bit chaotically presented and although it can be generally acknowledged as an applied contribution, there is no systematization of the exposure. The reviewer believes that this contribution needs to be better verbalized in order for the PhD student's claims to be accepted.

The reviewer accepts the contributions described in this way, recommending that the doctoral student learn to present his / her achievements more clearly.

6. Degree of the dissertation's personal participation in the contributions

The personal participation of the doctoral student is judged by the publication activity of the doctoral student reflected in the materials published on the dissertation. The doctoral student convincingly presents the achieved results, with very good and in-depth argumentation, as well as uses professional graphic design of the materials.

The nature of the research presupposes very good and wide preparation in the field of methods and means for integration, processing and modeling of heterogeneous data obtained from distributed IoT devices. I believe that the doctoral student has succeeded, without questioning her personal participation in the development of the dissertation material.

7. Evaluation of the publications on the dissertation

On the topic of the dissertation 12 publications were made, of which 2 independent in Bulgarian in national conferences with international participation and 10 in English in co-authorship in international conferences and magazines. The articles have been published in recognized international publications - six are in SJR, one in Q2, one in Q3, three in Q4, and two indexed in Scopus without SJR.

The reviewer reports the extremely high publication activity on the topic of the dissertation, covering the period 2017-2019 and made in renowned international scientific forums.

The publications reflect the more significant results achieved in the dissertation. They have been reported at renowned scientific forums, which I accept as approbation in scientific circles.

8. Conformity of the abstract with the requirements for its preparation and adequacy of reflection of the main positions and contributions of the dissertation

The presented project for the abstract is in accordance with the rules for preparation of the abstracts for the dissertations, indicated on the site of IICT-BAS. Reflects the results achieved as well as the contributions of the author. It is graphically very well designed and includes the necessary information describing the dissertation in a summary.

9. Opinion, notes and remarks

In the dissertation work a very complex, dynamically developing and perspective area is developed - methods and means for integration, processing and modeling of heterogeneous data obtained from distributed IoT devices. An innovative methodology for integrating heterogeneous data obtained from distributed IoT devices has been developed. An IoT platform architecture has been developed, consisting of hardware and software interconnected systems that communicate with each other. A practical application of the created system is given. This implies sufficient in-depth knowledge, the ability to interpret and formulate strategies for effective development of the field. The content and graphics of the material are very well developed. This material is of interest to a wide range of readers and if it is published after processing it will have a multi-applicative effect.

I recommend the doctoral student to continue his active publishing activity in scientific journals with impact factor.

I recommend a more accurate verbalization by the doctoral student of his achievements - to learn to state his contributions more clearly.

I have made some non-essential remarks on the copy provided to me.

10. Conclusion

The content and contributions of the dissertation of Mag. Kristina Ivanova Dineva fully meets the requirements of the Law for Development of the Academic Staff of the Republic of Bulgaria, of the Regulations for its application and of the

Regulations for the conditions and the order for acquiring scientific degrees in IICT-BAS. Significant research work has been carried out in terms of volume and content. There are a sufficient number of scientific and applied contributions. A sufficient number of publications on the dissertation published at prestigious scientific forums are presented. The educational doctoral minimum set in the individual plan is covered. The personal participation of the doctoral student in the development and the received contributions is indisputable. This gives me reason to strongly recommend to the Honorable Scientific Jury to award a Mag. Kristina Ivanova Dineva educational and scientific degree "Doctor" in professional field 4.6 "Informatics and Computer Science", specialty "Informatics"

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Sofia, 2020

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