

OPINION

By Assoc. Prof. Eng. Martin Milenov Kambushev, Ph.D.

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of the dissertation of mag. eng. KRISTIYAN SIMEONOV DIMITROV

on the topic „CYBER-PHYSICAL SYSTEMS FOR INTELLIGENT
MANAGEMENT OF ANIMAL HUSBANDRY COMPLEXES “

presented for the acquisition of the educational and scientific degree "doctor"

in a doctoral program

„Automated information processing and control systems“

1. Relevance of the problem developed in the dissertation work.

The topic of the dissertation is extremely relevant in the context of the concept of "Agriculture 4.0" and the introduction of the Internet of Things (IoT) in animal husbandry. Microclimate management in animal husbandry complexes is a key factor not only for economic efficiency and productivity, but also for animal welfare and the reduction of harmful emissions (NH₃, CO₂, CH₄) into the environment. Existing commercial solutions (from companies such as Big Dutchman, Fancom, SKOV), considered in the work, offer high quality, but are often financially inaccessible to small and medium-sized farms. In this sense, the development of an accessible, modular and open Cyber-Physical System (CPS), based on OpenHAB and inexpensive hardware components (such as ESP8266/ESP32), is a timely and practically significant scientific problem.

2. Degree of knowledge of the state of the problem and creative interpretation of the literary material.

The doctoral student demonstrates in-depth knowledge of the issue. The overview chapter (Chapter 1) and the analysis of existing methods (Chapter 2) show that the author is familiar in detail with both the biological requirements of different species of animals (cows, pigs, birds, fish), and the technical means for their provision. The bibliography contains 167 sources, most of which are current (from the last 5-10 years). A comparative analysis of leading world manufacturers of farm automation has been competently made. The creative interpretation is seen in the approach to creating one's own concept for a CFS, which does not simply copy existing solutions, but offers a flexible architecture based on protocols such as MQTT and Modbus, allowing the integration of diverse sensors and actuators.

3. Scientific and/or scientific and applied contributions of the dissertation work.

The dissertation solves all the tasks set and as a result of the theoretical research, computer simulations and practical tests carried out, the following contributions have been achieved, which can be summarized in the following categories:

Scientific contributions:

1. A new method for controlling the microclimate in a poultry farm has been developed, which is based on calculating the temperature felt by the birds, which is different from the temperature in the room and depends on the temperature, humidity and air speed, as well as the age of the chickens.

2. A new method has been developed for automatic control of nitrates, nitrites and ammonia in an aquaponic system, by controlling the amount of food supplied to the automatic feeder.

Scientific and applied contributions.

3. A conceptual architecture of the CFS for livestock farming has been created, based on open source (OpenHAB, InfluxDB, Grafana) and IoT protocols, which allows scalability and integration of sensors from different manufacturers.

II Applied Contributions.

1. Prototypes of the CFS for three types of livestock facilities (cow farm, pig farm, poultry farm) and one aquaponic system have been designed and implemented.

2. Two types of graphical user interfaces (based on Basic UI and HABPanel) have been developed, providing remote monitoring and control.

3. Experimental validation of the algorithms has been carried out through simulations and laboratory settings with the submission of synthesized data via an MQTT broker, proving the system's operability in real time.

The author's personal contribution is undeniable, which is evident from the independent development of the algorithms, software configuration, and hardware integration of the experimental setups.

4. Evaluation of publications on the dissertation work.

A total of 5 scientific publications are presented on the dissertation.

- 4 publications are in publications referenced and indexed in global databases (Scopus/Web of Science), including in authoritative journals such as Animals (Q1) and AgriEngineering (Q1), as well as in IFAC-PapersOnLine. This is an excellent certificate of the quality of the research.

- 1 publication is in a non-refereed journal with scientific review.

- Citations of the doctoral student's works by foreign authors are also noticeable, which speaks of the visibility of the results in the international scientific community.

The quantity and quality of the publications fully cover, and in terms of quartiles (Q1) even exceed the minimum national requirements for acquiring the ONS "doctor".

5. Opinions, recommendations and notes.

The remarks on the dissertation submitted to me for review are not significant and can be distinguished as follows:

1. Errors in formatting:

- Different fonts were used, for example, p.22, the explanatory text to Fig. 2.6;

- Punctuation errors.

- Figures such as 4.2 (Tasmota interface), 4.3 (MQTT.fx) and 4.4 (MG Configuration) contain an interface in English. Although this is a software interface, it is good to clarify in the text under the figure or in the description what exactly is seen, since the dissertation is in Bulgarian.

These remarks do not reduce the value of the dissertation.

Conclusion

The dissertation of M.Eng. Kristiyan Simeonov Dimitrov is a completed scientific study that meets the requirements of the Act on the Development of Academic Staff in the Republic of Bulgaria, the Regulations for its Implementation, the Higher Education Act and the generally accepted procedural rules for acquiring scientific degrees and occupying academic positions in universities and higher education institutions. The dissertation solves a current problem of great practical importance. The developed Cyber-physical systems and algorithms for microclimate management represent a contribution to automation in agriculture. The doctoral student demonstrates in-depth theoretical knowledge and excellent practical skills for implementing complex software-hardware complexes. All this gives me reason to give my POSITIVE assessment and to propose to the esteemed Scientific Jury to award Kristiyan Simeonov Dimitrov the educational and scientific degree "Doctor" in the doctoral program "Automated Systems for Information Processing and Management".

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