

OPINION

by Prof. Daniela Ivanova Borissova, DSc
from the Institute of Information and Communication Technologies – BAS,
Member of the Scientific Jury appointed by the Director of IICT-BAS via
Order No 111/26.04.2024

About: Dissertation thesis of Vasil Stefanov Kolev entitled “Design methods of wavelet and multiwavelet filter banks”, presented for the acquisition of educational and scientific degree “Doctor” in a doctoral program “Informatics”,
Professional field 4.6. “Informatics and Computer Science”

At the first meeting of the scientific jury, which took place on 13/05/2024, I was appointed to prepare an opinion on the procedure, for which I received all the necessary documents.

ACTUALITY

The wavelet theory has many applications in various mathematical and engineering fields such as denoising and compression of N-D signals, object extraction from astronomical images, machine learning, data sorting, database searching, time series analysis, etc. For this reason, the design of wavelet and multiwavelet filter banks is an up-to-date research direction.

KNOWLEDGE OF THE PROBLEM

From the overview made, as well as from the published results on the subject of the dissertation work, it can be established that the doctoral student is well acquainted with the nature of the researched issues. Additional proof of this is the number of literary sources used.

ANALYTICAL CHARACTERISTIC

The dissertation has a total volume of 150 pages, contains 36 figures, 15 tables and 153 literary sources. It is structured as follows: introduction, 5 chapters, conclusion, possibilities for future development, scientific and scientific-applied contributions, list of publications on the topic of the dissertation, list of citations, declaration of originality of

results, bibliography and 3 appendices. The purpose of the dissertation research is formulated on page 16, for the realization of which 6 tasks are additionally formulated on page 17.

Chapter 1 analyzes existing methods for developing wavelet and multiwavelet filter banks, including basis function theory for polynomials, splines, spectral decomposition, and building scalar (vector) filter banks.

Chapter 2 is focused on the proposed three methods for scaling and multiscaling functions from polynomials and splines – basis change method, direct method, and scalar product method.

In **Chapter 3**, existing spectral decomposition methods are presented. The proposed necessary smoothness condition of matrix filter product is described. A scaling function of Daubechies 4 is proposed by the method of roots of polynomials. Bauer's theoretical method for spectral factorization is also described and an Alpert product filter is obtained.

Chapter 4 describes the proposed fast Bauer method algorithms and their solution by three numerical methods. Two algorithms for a fast and accurate Bauer method for scalar and vector spectral decomposition are developed and Alpert orthogonal multifilter banks are constructed.

Chapter 5 contains a comparative analysis of the conducted experiments.

OBJECT AND METHODOLOGY OF THE RESEARCH

The object of scientific research is multiscaling and multiwavelength functions, and the subject is the development of multiscaling and multiwavelength functions and applications in various filters. The methodology used, based on analysis, synthesis, comparison, summary, and experimental research, is appropriately chosen and contributes to the realization of the set goal and the tasks formulated in the dissertation work.

ABSTRACT

The submitted abstracts, in Bulgarian and English, faithfully reflect the content of the dissertation work and correspond to the requirements of Law on the Development of the Academic Staff in the Republic of Bulgaria and the Rules for its Implementation. From the submitted declaration of originality, as well as from the publications on the subject of the dissertation, it can be determined that the described results are the personal work of the author.

**EVALUATION OF COMPLIANCE WITH THE MINIMUM NATIONAL
REQUIREMENTS AND THE ADDITIONAL REQUIREMENTS UNDER ART. 1A, AL. 2**

A total of 6 publications on the topic of the dissertation are presented. 4 of the publications are indexed in the world databases for scientific information, and 2 of them are in publications with IF. The presented publications on the subject of the dissertation research fully satisfy the specific requirements of IICT-BAS for the acquisition of the educational and scientific degree "Doctor", since the doctoral student has 104 points out of the required 30 points.

CONTRIBUTIONS

I accept the contributions formulated by the doctoral student, evaluating the first 3 as scientific and the rest as scientific-applied.

CRITICAL REMARKS AND RECOMMENDATIONS

The dissertation work is well balanced and I have no critical remarks and recommendations.

FINAL COMPREHENSIVE ASSESSMENT

The results obtained on the subject of the dissertation research convincingly show that Vasil Stefanov Kolev possesses the necessary theoretical knowledge and practical skills in the field of informatics and computer science, as well as proven abilities for independent scientific research. The presented dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria, the Rules for its Implementation, as well as the Rules for the Specific Conditions for Acquiring Scientific Degrees and Holding Academic Positions at IICT-BAS. **The obtained results on the topic of the dissertation research give me sufficient reason to give a categorically positive assessment of the presented dissertation work and I propose to the respected Scientific Jury to award Vasil Stefanov Kolev the educational and scientific degree "Doctor" in the doctoral program "Informatics", prof. direction 4.6. "Informatics and Computer Science".**

13 June 2024

Scientific Jur

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