

OPINION

by **Prof. Ivan Ganchev Garvanov, DSc,**

member of the Scientific Jury, appointed by the Director of the ICT-BAS

№ 88/29.03.2024 г.

SUBJECT: Dissertation by Vasil Stefanov Kolev on the topic "METHODS FOR BUILDING WAVELET AND MULTI-WAVELET FILTER BANKS", presented for the acquisition of the educational and scientific degree "DOCTOR" in professional field 4.6 "Informatics and computer sciences", with supervisor: Assoc. prof. PhD Rumen Andreev

1. Description

At the first meeting of the Scientific Jury I was selected to write an opinion and received the following documents:

- Thesis,
- Autoreferate in Bulgarian and autoreferate in English,
- List of printed scientific publications on the topic of the dissertation,
- Publications on the topic of the dissertation in full text,
- information on the fulfilment of the minimum requirements of the ICT,
- information on the fulfillment of the minimum national proof requirements in NACID,
- other documents related to the protection of the dissertation.

2. Actuality, purpose and tasks of PhD dissertation

The topic of the dissertation work is extremely relevant considering the need to expand the wavelet and multiwavelet theory. A major challenge for scientists is to obtain multiscaling functions such as the spectral factor of spectral decomposition of products of singular matrix filters with single or multiple zeros. The spectral decomposition of such a multifilter in practice is carried out with large errors and sometimes it is impossible. The scientific and scientifically applied results obtained in the dissertation are highly practical.

The aim of the dissertation work is to develop methods for building wavelet and multiwavelet filter banks.

To achieve this goal, the following scientific tasks have been formulated:

Task 1. To review and analyze existing methods for constructing scaling and multiscaling functions;

Task 2. To outline research opportunities in the development of new methods for constructing filter banks;

Task 3. To propose new methods for developing scaling and multiscaling functions from polynomials and splines;

Task 4. To define and develop spectral decomposition methods;

Task 5. To develop algorithms for a fast and accurate Bauer method;

Task 6. To synthesize a lifting scheme of Alpert's multi-filter bank and conduct experimental studies with the developed methods for building wavelet and multi-wave filter banks.

3. General characteristics of the dissertation work

The submitted Dissertation work consists of 150 pages structured in an introduction, five chapters, conclusion, contributions, opportunities for future development, list of publications on the dissertation, list of noted citations, declaration of originality, bibliography and three appendices.

Chapter 1 reviews existing methods for developing wavelet and multiwavelet filter banks.

Chapter 2 shows three methods for constructing scalar and multiscalar functions from polynomials or spline functions—the change-of-basis method, the direct method, and the scalar product method.

Chapter 3 describes existing spectral decomposition methods.

Chapter 4 develops algorithms for Bauer's fast method and solves them with three numerical methods.

Chapter 5 is devoted to: Comparative analysis of the four methods for developing scaling (multiscaling) functions, Bauer's methods for Haar scaling functions, Dobecky 4, and Alpert's multiscaling function; An experimental study of Bauer's fast and accurate method for Haar and Dobeshi scaling functions 4; Investigation of the exact BMB method

by applying Algorithm 2 for scalar and six matrix polynomials; Investigation of the exact BMB method using built-in software functions for seven examples; Development of an Alpert multifilter lifting scheme in an orthogonal multifilter bank for gray level image analysis and reconstruction with different quantization; Comparative analysis of orthogonal scalar and vector filters for image compression from scanned photographic plates.

The results are presented in 36 figures and 15 tables. 153 literary sources were used.

4. Contributions

I accept all the contributions of the doctoral student and consider them to be of a scientific and scientific-applied nature. In his research, the doctoral student confirms some known facts, an existing scientific field is enriched with new knowledge, and some of the newly obtained scientific results are proposed to be applied in practice.

5. Abstract

The presented two versions of the abstracts in Bulgarian and English faithfully reflect the content of the dissertation and comply with the requirements of the Law on the Development of Academic Staff in the Republic of Bulgaria. From the attached declaration of originality of the presented results, as well as from the submitted publications on the dissertation, it can be judged that the described results are a personal work of the doctoral student.

6. Assessment of compliance with minimum national requirements

PhD student **Vasil Stefanov Kolev** has approved parts of his dissertation work in six scientific publications, four of which are indexed in Scopus and/or WoS, two of them have IF with Q1 and Q3, and one is with SJR. Ten citations were noted for three of his publications.

According to the minimum national requirements for obtaining of the educational and scientific degree “Doctor” in the professional field 4.6 “Informatics and computer science”, the required scores are to be at least 30 for the group of indicators G. The same number of scores is required by the Regulations on the Conditions and Procedures for

Acquisition of Academic Degrees and Occupation of Academic Positions in BAS and the Regulations on Specific Conditions for Acquisition of Academic Degrees and Occupation of Academic Positions in IICT-BAS. The dissertation publications presented form a total of the points for the indicators from Group G equal to 104 points, which exceeds the required minimum of 30 points.

The protocol of the anti-plagiarism system StrikePlagiarism has shown conclusively that the dissertation is original and authentic.

7. Notes and recommendations

I have no notes and recommendations for the doctoral student.

8. Final comprehensive assessment

I believe that the submitted dissertation meets the requirements of the Law on the Development of the Academic Staff in the Republic of Bulgaria. The achieved results give me reason to give a positive assessment with complete conviction and I recommend the honorable Scientific Jury to award the educational and scientific degree "Doctor" to **Vasil Stefanov Kolev** in a professional field 4.6. "Informatics and Computer Science".

11/06/2024

Sofia

