

## ATTITUDE OF REVIEWER

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on: the procedure for the thesis defense with title: Design Methods of  
Wavelet and Multiwavelet Filter Banks,

with author: VASIL STEFANOV KOLEV – independent form of training

for: to award educational and scientific degree "Doctor" (PhD)

in: Field of Higher Education 4. "Natural Sciences, Mathematics and Informatics",  
Professional field: 4.6 "Informatics and Computer Sciences"

### 1. Grounds and general description of the presented materials

By order № 111/26.04.2024 of the Director of IICT-BAS, pursuant to Art. 4, Paragraph 2 of the "Law on the Development of the Academic Staff in the Republic of Bulgaria" (LDASRB), Art. 30 of the "Regulations for Implementation of LDASRB" and Art. 6 of the "Rules on the Terms and Conditions for Acquisition of Academic Degrees and Occupation of Academic Positions at BAS", and in accordance with a decision of the Scientific Council of IICT-BAS (Protocol № 5/24.04.2024) I have been appointed as a member of the Scientific Jury under the procedure described above. As a member of the Scientific Jury at its first meeting (Protocol № 1/13.05.2024) I was assigned to write an opinion and received the materials for this procedure.

The following is an inventory of the materials at my disposal: (1) List of publications on the Dissertation; /there are 5(five) publications in this list;(2) Certificate of fulfillment of the minimum requirements of IICT-BAS. (the coefficients of the points of professional directions /PD/ 4.5 and 4.6, for publications and citations are 2 and 3 respectively);(3) Material for registration in National Center for Information and Documentation (NCIaD or NACID) (the points are different because the coefficients by which the points are multiplied for publications and citations in PD 4.5 and 4.6 are 3 and 4 respectively);(4) Order № 88/29.03.2024, on the basis of Art. 24, Paragraph 4 of the "Regulations for Implementation of the Law on Development of the Academic Staff in the Republic of Bulgaria" and decision of the Scientific Council of IICT-BAS (Protocol № 3/27.03.2024); for Deduction of Vasil Stefanov Kolev from doctoral studies of self-study with the right of defense as of 01.03.2024;(5) Dissertation – 150 pages, (details follow below);(6) Abstract in Bulgarian – 54 pages;(7) Abstract in English – 40 pages.

The following are the details of the Dissertation. The dissertation contains a total of 150 pages, including: Table of Contents, Supporting Lists (5 pcs.), Introduction, five Chapters; Conclusion, Opportunities for future development, Contributions to the dissertation, Lists of: the author's publications on the topic, of the citations of these publications; Declaration of originality; /respectively 1+1+1+1+2+1=7 pages/, Bibliography (9 pages, with 153 sources); three Appendices /2+3+1=6 pages/.

The dissertation begins with *Table of Contents* – 3 pages, *Lists of:* the used designations, concepts, abbreviations-5 pages; the tables (15 pcs.)-1 page, the figures (36 pcs.)-2 pages, /together with the title page, the Acknowledgments and the motto become 14 p./ and *Introduction*-5 pages, where are considered: *Relevance* of the topic, *Motivation* of the author – four methods for development of scalar or vector scaling functions from polynomials and splines; Scientific formulation of the study – object and subject; *Objective* of the dissertation work; the main *Hypothesis* – having two aspects; Implementation and proof of the hypothesis, *Methodology* of the study – four methods for constructing filter banks have been developed; *Main tasks* of the research – six tasks are formulated; participation in *Projects* – a contract funded by BNSF /Bulg. National Sci. Fund/ with astrophysicists is cited; and ends with the *structure* of the content of the Dissertation.

Chapter 1 (31 pages) reviews and analyzes methods for constructing wavelet and multiwavelet filter banks. Includes basis function theory for polynomials, splines, spectral decomposition, and filter bank construction.

In Chapter 2 (24 pages) methods for constructing scaling and multiscaling functions of polynomials or spline functions are developed.

In Chapter 3 (9 pages) spectral decomposition methods are developed. Existing spectral decomposition methods are described – method of roots of polynomials, method of quadratic equations, Cepstral method, and Bauer method. A necessary smoothness condition of matrix filter product is developed. Basic theory for Bauer's method is described. An author's work on an Alpert product filter is obtained, which is also the main result in this Chapter in conjunction with Task 4.

Chapter 4 (9 pages) develops two algorithms, for Bauer's Fast and Exact Method, and their solution with three numerical methods. Alpert orthogonal multifilter banks are constructed. Two authors' options for finding symmetric wavelets have been developed Alpert functions. Two proprietary numerical methods have been developed for solving Nonlinear Matrix Equations (NME) for Fast Bauer Method (FBM) and their computational complexity is presented.

In Chapter 5 (36 pages) the classical and fast methods were experimentally investigated Bauer's Spectral Decomposition and Comparative Analysis through 7 Examples as well as building Haar, Daubechies 4 scaling functions, and Alpert's multiscaling function. Different applications of orthogonal multiwavelet filters (GHM = 'Geronimo - Hardin - Massopust', CL = 'Chui - Lian', Alpert) for processing gray level test images and scanned photographic plate (SFP) images are compared. Two new author's supercompact orthogonal multifilters have been developed, an author's lifting scheme of Alpert's multifilter has also been developed and studied. The results (and parts of them) in this chapter are reflected in 4 author publications.

They follow: Conclusion /1 page/; Opportunities for future development /1 page/; Contributions to the dissertation work /1 page/; List of the author's publications on the subject /1 page/. It consists of 6 (six) publications. One is in Bulgarian and the rest are in English. In the materials are the publications themselves, and below follows a more detailed examination. List of citations /2 p./. They are not required for this type of

procedure, but it is commendable that they are available /number is 10/. Declaration of originality /1 page/. It is required by the Regulations. It is made according to the pattern. Bibliography /9 pages/ Contains 153 sources. Also included are the author's dissertation publications – 6 (six issues) from [85] to [90]. There are a total of 13 in Cyrillic – 12 at the beginning of the Bibliography, and 1 of the author, [86]. Appendices /6 pages/ are three (3) in number, although the author wrote otherwise in the dissertation /see on page 19, “and 2 appendices”/.

2. Evaluation of works and other activities taking into account the fulfillment of the minimum requirements of IICT-BAS.

We limit ourselves to the requirements of the IICT-BAS (according to Art. 2-b, Paragraph 5 of the LDASRB), because the national requirements (from the previous paragraph 2 and paragraph 3) and those of BAS are not stronger, they are even weaker, especially for PD 4.5 and 4.6.

Group indicators	Content of the group indicators	Requirements of IICT-BAS for PhD	Metrics of assistant V. Kolev for IICT ; for NCIaD
A	Indicator 1 (dissertation)	50	50
B(C)	Indicators 3 or 4	— —	— —
Г(D)	Indicators from 5 to 10	30	92 ; 138
<b>Total</b>	<b>by all groups indicators</b>	<b>80</b>	<b>142 ; 188</b>

Indicators (5-10) for publications (respectively group D)

For publications of this type, the requirement is 30. From the presented 3 publications in the materials of this procedure /see (2),(3) of the Inventory above/, in the cell of the table, respectively, 92 points are collected according to the requirements of IICT and 138 points according to those of NCIaD. The calculation is:

$$1*2*25[Q1] + 1*2*15[Q3] + 1*2*6 = 92; \text{ and } 1*3*25[Q1] + 1*3*15[Q3] + 1*3*6 = 138.$$

No points from citations /group Д(E)/ and participation in projects /group E(F)/ are provided for this procedure.

3. Assessment of contributions in the dissertation work.

The achievements in the dissertation correspond to the set goal and the tasks that arise from it. The author formulated 3 scientific and 4 scientific-applied contributions. They correspond to the actual results achieved in the dissertation work. At the end of each chapter there are conclusions about what was done in that part. This makes it easier for the jury on this procedure.

I will not list here the contributions in the dissertation work, because they are also affected in the previous points of this opinion.

#### 4. Evaluation of publications and citations.

The results included in the dissertation work are based on 6 publications: (2) two are with IF – one in Q1, one in Q3; the rest are in conference proceedings.

Regarding the language: one is in Bulgarian, the rest are in English.

In terms of years: three are from before 2010.

Regarding the number of co-authors – four are independent, two have two co-authors each.

Citations are not required for this procedure, but for the author's pride and to facilitate the jury's decision – there are citations visible through SCOPUS.

#### 5. Abstracts. (in Bulgarian and English)

In general, the author's Abstract in Bulgarian correctly reflects the content of the dissertation. Its volume is 54 pages. The numbering of formulas, figures and tables in the Abstract and in the Dissertation in most places differ, which is normal, and in other places they match. The Bibliography from the dissertation has been completely carried over to the abstracts, which is good for those who only have access to the abstracts. The situation is different with the author's Abstract in English, which is 40 pages long. The differences with the Dissertation and with the other Abstract are greater, but this does not prevent the understanding of what the dissertation was done.

#### 6. Critical notes, praise and recommendations.

Some inaccuracies and technical errors are also noted. The following is the mention of some of them: (1) In the Author's abstract in Bulgarian (on page 19) Fig. is cited. 2.3, which is missing; (2) The number of author publications in the lists attached to the Abstracts is different (5 – in the English version, 6 – in Bulgarian), in the Dissertation it is the same as in the Abstract in Bulgarian; (3) There are duplicate formula numbers – on p.90, (4.42), p.65 - (3.31); holes in formula numbering – missing (4.8), (4.34)-(4.38), (5.10), and not all numbered formulas are referenced in the text (see recommendation below); (4) "Bayer" appears instead of "Bauer" in the Dissertation and in the Abstract in Bulgarian it is almost cleared ( $\times 2$ ), but in the Abstract in English "Bayer"/"Bauer" is not ( $\times 6$ ); (5) Some abbreviations for method names are missing and/or inappropriate.

That the reviewer has pointed out such inaccuracies serves as proof that he has read the materials in detail. I declare that this does not impair my good impression of the proposed work.

Among the praises, we can mention: (1) The bibliography from the dissertation has been completely transferred to the abstracts, which is very useful for readers without access to all the materials; (2) The last section of each chapter is "Results and Conclusions" and is a great convenience for reviewers because it indicates for which main tasks of the dissertation the results were obtained and in which author's publications the results (or part of them) are presented.

It would be easier for the members of the jury to include the number of the section in the dissertation to the numbers of the tables and figures, and why not to the formulas, and to indicate the corresponding number in the Dissertation in the Abstracts.

Recommendation: to consider publishing this dissertation, or parts of it, as a separate book.

7. Personal impressions about the candidate and other data not specified in the previous points. I know the doctorate student Vasil Kolev personally. This is the place to declare that we have no conflict of interest within the meaning of the rules and regarding my participation in this Scientific Jury.

A search through SCOPUS of the author's name shows 9 publications, which collect 20 citations (excluding self-citations). Not all publications are on the dissertation, but these scientific metrics speak for themselves about the quality of the author's output.

I have been familiar with Vasil Kolev's work for many years and I have very good impressions of his curiosity and ability to work.

#### 8. Conclusion.

Considering that: the candidate has sufficient scientific and scientific-applied contributions; what has been achieved has been announced to the scientific community in sufficient and high-quality publications and scientific symposia – and all requirements, conditions and criteria have been met according to: *Law on the Development of the Academic Staff in the Republic of Bulgaria (LDASRB), Regulations for the implementation of the LDASRB, Regulations on the terms and conditions for the acquisition of scientific degrees and for the occupation of academic positions at the BAS, also Regulation on the specific conditions for acquiring scientific degrees and for employment of academic positions in IICT-BAS.*

*I have grounds for the following conclusion:*

I give a positive assessment of the materials with which the candidate VASIL STEFANOV KOLEV participated in the procedure for the defense of a dissertation work on the topic: Methods for constructing wavelet and multiwavelet filter banks for awarding the educational and scientific degree "doctor"(PhD) in the field of higher education: 4."Natural sciences, mathematics and informatics" professional direction: 4.6 "Informatics and computer science"

I recommend to the esteemed members of this jury to positively evaluate our thus proposed dissertation work and award to VASIL STEFANOV KOLEV the educational and scientific degree "DOCTOR" (PhD).

June, 17, 2024

Sofia

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