

## REVIEW

in a competition for the academic position of "Professor" in professional field 5.2. "Electrical Engineering, Electronics and Automation", specialty 02.21.07. "Automated systems for information processing and management", announced in "State newspaper" № 57 / 09.07.2021 for the section "Information technologies for sensory data processing",  
with candidate: **Assoc. Prof. Dr. Kiril Metodiev Alexiev.**

**Reviewer: Prof. DSc. Andon Dimitrov Lazarov**

### 1. General provisions and biographical data

Assoc. Prof. Dr. Kiril M. Alexiev is Head of Section at the Institute of Information and Communication Technologies (IICT), Bulgarian Academy of Sciences (BAS). His scientific and managerial activity is in the field of sensor information processing.

With a protocol № 6 from 23.06.2021 of the Scientific Council of IICT-BAS a competition for the academic position "Professor" was announced in professional field 5.2. Electrical engineering, electronics and automation, specialty "Automated systems for information processing and control". By Order № 200 of 07.09.2021 on the base of Art. 4, para. 2 of ZRASRB and a decision of the Scientific Council with protocol № 6 from 23.06.2021, a Scientific Jury was appointed for the competition for the academic position "Professor", in staff of which Prof. DSc. A.D. Lazarov was included. At the first meeting of the Scientific Jury with Minutes № 1 from 21.09.2021, Prof. Dr. Sc. A.D. Lazarov has been appointed as a reviewer.

### 2. General description of the submitted materials

The candidate has submitted for review 48 scientific papers. Three of them are chapters published in books from the series "NATO Science for Peace and Security Series" (1 published by Springer and 2 by IOS Press). The candidate has indicated participation in 25 research projects, he cited also one Certificate of invention USSR N636045 class B 07 C 5 / 10,1978 dated 30.09.1985, Bulletin No. 36.

In SCOPUS are referred 17 publications (one is in the process of printing). There are 15 references in WoS and 3 in MathSciNet. One article is referenced in PACIS (the South American equivalent of WoS).

14 publications are referred in NACID.

Two of the articles were published as "white papers", one in the framework of PRACE (Partnership for Advanced Computing in Europe) and the other in the framework of VLADA (Virtual Lab for Advanced Data Analysis).

Seven of the publications are in Bulgarian, 41 are in English. Ten of the publications are with IF and/or SJR.

In 7 publications, the candidate is the only author, in 15 publications he is the first co-author, in 26 he is the second, third, etc. co-author.

48 scientific papers that are outside the dissertation and are taken into account in the final evaluation are accepted for review. 3 chapters printed in books from the NATO SPS Series, 25 research projects and one Certificate for invention are not reviewed.

From the given reference it follows that Assoc. Prof. Dr. Kiril M. Alexiev exceeds many times the requirements of the scientometric criteria of NACID and IICT-BAS for the academic position "Professor".

According to indicator A - 50 points.

By indicator B (3, 4) Habilitation work/Scientific publications (not less than 10) in journals that are referenced and indexed in the best academic research databases - 322 points.

According to indicator D (5-9) Scientific publications in journal that are referenced and indexed in the best academic research databases - 429.1 points.

According to indicator E (12-14) Citation or review in scientific articles, referenced and indexed in the best academic research databases, or in monographs and collective volumes - 2059 points.

According to indicator E (16 -) Participation in national scientific or educational projects - 430 points.

Based on the reference and evidences provided for the scientific production of Assoc. Prof. Kiril M. Alexiev, it can be concluded that the candidate fully meets the national scientometric criteria for the assignment of the academic position "Professor".

### **3. General characteristics of the research and applied activity of the candidate**

Assoc. Prof. Dr. Kiril M. Alexiev works in the field of systems for automated signal and image processing. The scientific production of the candidate can be divided into the following thematic areas:

1. Methods and algorithms for signal processing.
2. Methods and algorithms for image processing.
3. Methods and algorithms for multisensor data processing (data/information fusion) for multitarget tracking and visualization.

The evaluation of the candidate's research activity in these thematic areas can be given by the results published in the scientific articles in journals that are referenced and indexed in the best academic research databases. These papers are equivalent to a habilitation thesis from the reference for fulfillment of the minimum requirements of IICT for "Professor".

Methods for self-similar decomposition of digital signals in time domain [2] and compact signal encoding [3] have been developed, the nonlinearity estimation of digital signals has been also proposed [4]. A software solution has been proposed to enhance accuracy and precision of eye tracker by head movement compensation and calibration using accelerometers and gyroscopes in the eye tracking system [6].

A non-contact acoustic approach has been developed for detection of technological and operational faults of ball bearings [9]. The proposed method could be applied for distant monitoring and prediction of wear of ball bearings. A base of fuzzy rules is proposed for intelligent measurement fusion from two types of sensors in a MEMS system with three accelerometers and three gyroscopes placed on the axes of a 3D coordinate measuring system [12]. An intelligent approach is defined for extracting functional dependences from multidimensional arrays of measurements, obtained from 18 microphones and a video camera [14].

A concept has been developed for the use of smart phones as a measuring laboratory and processing center for recording and analyzing human activity [17]. The methods of fuzzy logic and neural networks were applied for determination the optimal values of the covariance matrix in the Kalman filter for the case of gyroscope measurement filtration in a MEMS device [19]. An approach for 3D visualization of sound fields in an acoustic camera [20] and clustering of dynamic sound fields using a neuro-fuzzy approach [22] has been developed.

#### **4. Assessment of the pedagogical activity of the candidate**

Assoc. Prof. Dr. Kiril M. Alexiev performs teaching and pedagogical activities at the Technical University of Gabrovo, Technical University of Sofia, the Higher School of Telecommunications and Posts, Sofia University. He was a supervisor/co-supervisor of graduates. He participated also in all sessions of the "Student Internships" program. At the moment there are two doctoral students who are facing the defense of their dissertations.

Lecture courses:

- "Modern protocols for transmission of multimedia content", TU Sofia.
- "Sensors. Sensor networks. Sensor information processing ", Technical University - Gabrovo, 2008.
- Lectures at the Higher School of Telecommunications and Posts 2015 - 2018.
- Lecture course "Industrial Mathematics", Sofia University - Sofia, 2020 - 2021.

#### **5. Main scientific and applied scientific contributions**

##### **Scientific contributions**

##### **1. Methods and algorithms for signal processing.**

- Methods and algorithms have been developed for processing and evaluation of information characteristics and parameters of signals generated by different types of sensors, based on which a segmentation is performed, detection of self-similarity according to certain criteria, which allows description of signals by using a library of specific segments for any particular signal and their time order [2,8].

- Algorithms have been developed for compact signal encoding [3], estimating its nonlinearity [4], detecting and evaluating non-stationary signals, detecting non-stationary Winer signal in the presence of non-stationary Winer noise in the channel by the maximum likelihood method [24].

##### **2. Methods and algorithms for image processing.**

- An approach for detection of point buried targets with application of Hough transform has been developed for ground penetrating radars [40], as well as Doppler algorithm for acoustic ultrasound detection of disorders in the texture of human organs [33]. Creation of new classifications, methods, constructions, technologies.

- Algorithms have been developed for the restoration of a 3D object by 2D images with dynamic evaluation of the camera parameters [39, 41,42,45].

### 3. Methods and algorithms for multisensor data processing (data/information fusion) for multitarget tracking and visualization.

- An approach for information fusion and spectral analysis of spatial information from 18 microphones and one video camera for determining the sources of noise has been developed [9], an assessment of the state (technical and technological) of operation of roller/ball bearings has been proposed [14]. The structure of the acoustic diagram of a microphone array has been studied [25].

- A method has been developed for gyroscopes and accelerometers measurements fusion by using fuzzy logic [12], in order to increase the reliability in determining the forces acting on the body. A generalized model of sensor node and sensor networks and the concept for multiple sensors data fusion have been developed [43, 44, 47].

- A method for 3D visualization of the neuron activity of a segment of the cerebral cortex containing several thousand neurons has been developed [38]. A solution for visualization of 3D surfaces in their description with polysplines [48] has been proposed.

Scientific contributions can be attributed to the creation of new classifications, methods, constructions, technologies in the fields of sensory signal and image processing.

#### **Scientific and applied contributions**

##### 1. Methods and algorithms for signal processing.

- A signal self-similar decomposition algorithm has been developed, which is applied for processing of ECG signals [1] and recovery of telemetric information received from satellites [5]. Creation of new classifications, methods, constructions, technologies.

##### 2. Methods and algorithms for image processing.

- For automatic detection of various geological structures and various natural phenomena, the linear elements detection system in multi-spectral satellite images of the Rhodope region, a system of edge detection filters, directional filters [23] and a neural network [23,31] has been built. In [29] the main sources of errors in spectral observations are classified as those arising from external sources and errors generated by the sensor itself. The methods for error estimation in such observations and correction (if possible) are analyzed in [30].

- A system for parallel processing of ultrasound images for detection of prostate cancer has been proposed, which includes filters for multiplicative noise, algorithms for texture analysis, image segmentation and fusion (matching) of normal ultrasound images with Doppler one of the prostate [33].

- A system based on a supercomputer with parallel implementation of algorithms for detecting and recognizing faces in public places with a large flow of people [34] is proposed.

- A software package has been developed for analysis of patients with impaired visual perceptions by generating test images with random trajectories and application of Hough transform [32, 36, 37], specialized software for image processing with super resolution for evaluation of physical parameters of captured persons, software for modeling the transport flow, estimating the load of a car by determination of its clearance in a sequence of images obtained

from a video camera, as well as software package for detecting of buried point objects in images received by ground penetrating radar [11, 13, 46 ].

### 3. Methods and algorithms for multisensor data processing (data/information fusion) for multitarget tracking and visualization

- A mobile application is proposed for energy expenditure estimation using inertial sensors built into mobile phones [16, 17], ESN algorithms for dynamic visualization and reduction of uncertainty in the estimation of the covariance matrix in the Kalman filter, defined by a system of fuzzy rules, ESN network of acoustic wave propagation [20,21,22,26].

- A concept has been developed for application of smartphones with its sensors and sensor data for the needs of educational process in the universities and schools. A simulator of inertial sensor signals (accelerometers and gyroscopes) is proposed [18, 27, 28], as well as a virtual laboratory for data processing in the White Paper of VLADA [35].

Scientifically applied contributions can be attributed to the creation of new classifications, methods, constructions, technologies in the fields of sensory signal and image processing.

Despite the dominant number of joint publications with other authors, where the candidate is in prestigious position and a relatively convincing number of individual publications, it can be convincingly stated that the cited contribution claims belong to the candidate.

## 6. Significance of contributions to science and practice

The scientific and scientific-applied contributions are distinguished by high scientific and applied value in terms of volume of quality and exceed the institutional quantitative indicators for holding the academic position "Professor". Assoc. Prof. Dr. Kiril Alexiev is a renowned scientist with international prestige and recognition. Proof of this are the impressive number of citations of his works in authoritative international journals and conferences, as well as his participation in a number of international projects. In accordance with the reference for the citations of Assoc. Prof. Dr. Kiril Metodiev Alexiev, the number of cited publications of the author is 32, and the total number of citations is 208. The candidate indicates also one Certificate for invention.

## 7. Critical remarks and recommendations

Recommendation: to increase its teaching activity in order to expand the audience to promote his scientific results, experience and competencies.

## 8. Personal impressions and opinion of the reviewer

Assoc. Prof. Kiril M. Alexiev is a highly erudited scientist in the professional field of the competition. He has active publishing and productive research activity. He maintains also extremely intensive international contacts. He is an organizer of a number of international scientific forums, editor and reviewer of international journals.

## CONCLUSION

The scientific output of Assoc. Prof. Dr. Kiril M. Alexiev in quantitative scientometric indicators exceeds many times the institutional and national criteria for holding the academic position of "Professor". Based on the acquaintance with the presented scientific works, their significance, the scientific, scientific-applied and applied contributions contained in them, I find it reasonable to propose Dr. Kiril Metodiev Alexiev to take the academic position of "Professor" in the professional field 5.2 "Electrical Engineering, Electronics and Automation", in the specialty 02.21.07. "Automated information processing and management systems".

Date: 15.10.2021

REVIEWER: .....

(Prof. Dr. Andon D. Lazarov)

