REVIEW

for a competition for the academic position of **"associate professor"** in a professional field 4.6. Informatics and computer science (image processing), announced for the needs of Section "Information Technologies for Sensor Data Processing" at IICT-BAS in SG No. 68 / 31.07.2020, approved by the National Assembly on 30.09.2020

Reviewer: *Assoc. Prof. Dr. Danail Stefanov Brezov*, Department of Mathematics, UACEG member of the scientific jury appointed by order No. 194 of 07.10.2020 of the Director of IICT- BAS, Prof. Dr. G. Angelova, on the grounds of Art. 4 para. 2 of ADASRB and the Regulations for its implementation approved by the Scientific Council of BAS

Candidate: *Dr. Dimiter Petkov Prodanov*, IMEC Leuven, Belgium

1. Brief biographical data about the candidate

Dimiter Prodanov was born in 1975. In 1999 he obtained Master's degree at the Medical University of Sofia. As a student, he showed interest in experimental research, as can be seen from an early 1998 publication - P1998G. In 2006 he defended his doctoral dissertation at the University of Twente, the Netherlands, titled "Morphometric analysis of the rat lower limb nerves. Anatomical data for neural prosthetisis design", which combines tasks of biomedical engineering with applied methods of mathematics and computer science: from signal and image processing, to design of neuroprosthetic implants. The main focus of the dissertation is the development of methods for quantitative analysis of the distribution of neuronal fibers in histological preparations of marked nerves (P2008B). One of the most widely used internationally applications from the period is the MIJ package - https://imagej.net/Miji. The module allows startup of ImageJ in MATLAB environment and exchange of images and measurements between the two programs. The package is currently being distributed with Fiji. During his graduate studies, Dimiter Prodanov also participates in two research projects: one in Twente, under the Marie-Curie program, c within the NeuralPRO research network (FP5), and one at the Medical Center at University of Leiden LUMC, until the completion of his dissertation. Then, he did his postdoctoral studies at the Catholic University of Leuven, Belgium, working on a project funded by IBRO scholarship, in the field of functional topography of nerves, examined with electrophysiological methods (P2008G).

During the period 2007 - 2008 Dr. Prodanov was appointed to the Research Center for cell and molecular neurobiology at the University of Liège, where he dealt with measurement of bioelectrical signals in experimental models of migraine and vagus electrical stimulation, as well as with image analysis. The development of the experimental information system LabIS, which is presented in P2008G and P2011B, dates back from this period. In 2008, DP started working at the IMEC Research Center, Leuven, where he took a job various positions: senior researcher from 2008 to 2012 and associate researcher to the NERF research network since 2013. There he worked in a number of areas: from creating interfaces for recording deep brain stimulation, to multi-scale techniques for analysis in light microscopy, nonlinear phenomena in the brain, abnormal tissue transport and biological response to neuronal prosthesis implantation.

The research in the field of neurophysiology Dr. Prodanov combines with R&D, in IMEC he is also engaged in technological risk assessment in the period 2013 - 2016, after which he managed the NanoStreeM project under the H2020 program until 2019. The documentation of the procedure is complemented by an official note, which shows that during the period 2019 - 2020 the candidate has experience as a programmer in IICT, BAS, although this is not included in his resume. It also lacks information on secondary education candidate, but has reported experience in leading students, working in international teams and the organization of scientific meetings, which I can confirm from my personal observations.

2. Scientometric indicators and documentary compliance

From the materials presented in the competition it can be seen that the candidate covers, with large advance, the necessary minimum requirements for participation under the Act for the Development of the academic staff in the Republic of Bulgaria (ADASRB), according to the current amendments and amendments, promulgated in the State Gazette (SG) No. 17 of 25 February 2020, and the Regulations for its implementation in the Bulgarian Academy of Sciences. Some of the points provided for in the regulations, for example for attracted funds for a project have not been reported - the applicant has obviously decided that it is not necessary.

A total of 28 publications in international indexed and referenced (SCOPUS and/or Web of Science) editions were presented, of which: 3 as habilitation equivalent, 11 other articles in scientific journals, 12 conference papers and 3 chapters in collective monographs; 9 of the works are in journals with impact factor, of which 6 fall into the first two quartiles. Only 2 of the works are independent, and the rest - in co-authorship, as the number of authors varies between 2 and 10, which can be explained given the multidisciplinary field and the combination of theoretical research and experiment with often complex technical support.

Evidence of 151 independent citations of the candidate's work is presented through printouts from the SCOPUS database, participation in two research projects, one of which international, and management of another, again international project. Also included documents certifying work experience in the specialty and a recommendation from the present employer, diploma for educational and scientific degree "Doctor" from the University of Twente, the Netherlands, as well as an official note from NACID confirming that the applicant appears in the national register. All required by ADASRB and the relevant regulations for its application documents are available and, as far as I can judge, authentic. For the convenience of the jury, additional excerpts from SCOPUS and a reference from the NACID database are presented as well.

3. Overview of scientific work and main contributions

The candidate has grouped his research in several main areas. The first of these is entitled Neuro-Informatics for Signal Processing and Analysis data and includes publications P2008B, P2011B and M2013B. While the first is closely related to the topic of his doctoral dissertation, the second one offers an original author's dissertation development of a web-based integrated information system (LabIS) for image recording, sharing, processing and quantitative analysis compatible with popular software packages such as MATLAB and ImageJ. The system finds application in the next article from this series in solving a specific task of neurophysiology. Since 2014 year Dr. Prodanov leads a project developing a platform for segmentation of images (Active Segmentation), based on machine learning - previous versions are demonstrated in short messages [V2015G, V2016G] and reported at international scientific meetings. The chapter P2012G in the collective monograph Molecular Imaging, studies image processing

algorithms based on mathematical morphology and parametric optimization. Article P2015B deals with the application of Gaussian multi-scale spaces in the analysis of microscopic images are demonstrated the advantages of the anisotropic decomposition of the fractional Laplacian for the Gaussian filter, as well as the connection with alpha-scale spaces. Two other interesting publications closely related to the topic of the competition are D2019B and A2019B. The former offers a comparative analysis of different approaches to image segmentation and their application in botany, while the latter presents and demonstrates an algorithm for self-similar decomposition of digital signals.

This group includes a number of short presentations, invitet talks and lectures at international conferences, summer schools and doctoral courses: P2013G, P2011C, V2015G, GF2015G, K2013G, P2008. They cover issues related to the analysis and segmentation of images in microscopy, LabIS and Active Segmentation platforms are demonstrated, as well as their integration with other software products. This direction of scientific and applied research of the candidate is most closely connected with the objectives of the announced competition. At the same time, it seems his expertise and achievements are mainly in this area, especially in recent years, as evidenced by the extensive recommendation from the current employer, the Director of NERF, IMEC, Prof. Dr. Sebastian Haesler.

The next area of scientific work of the candidate is computer algebra approach to computational biology, and in particular the application of Clifford's geometric algebras. Here Dr. Prodanov offers an original author's contribution with publication P2017G, in which he describes his own software package Clifford, integrated into Maxima. The product in many respects surpasses similar developments backed by large universities and software companies. In the article one may find demonstrations in various applications: from visualization of geometric objects and coordinates transformations to obtaining the fundamental solution of the Poisson equation and variational problems. Publication P2017G2 further develops and enriches the idea provided in P2017G, comparing the indicative representations of geometric algebras in Maxima, in the context of the Maxwell's equations of electrodynamics. In P2016B it is applied in problems related to the modeling of cell migration and diffusion of soluble substances around the implant, with fractional calculus methods, as for some cases even analytical solutions have been obtained. Clifford's algebras, initially introduced in the context of classical geometry and mechanics, are gaining more and more popularity in high-tech applications: from navigation and robotics, through images processing, to computer vision and artificial intelligence. That is why I consider the developments of the candidate in this field particularly relevant to the topic of the competition, and his contribution to the development of specific biophysical and computational applications of the algebraic approach, as well as its promotion among the scientific community, is undoubtedly appreciated by the international scientific community.

The third main area of scientific and applied work, noted in the application, is in the field of neuroprosthetics and neuroplasticity of the central nervous system. Here publications W2013G, ML2012G, B2010G, M2009G, M2010G and P1998G are included, as well as the brief reports M2011G, P2009G, P2008G. It is impressive that more recent publications of the candidate in this category are increasingly focused on multipurpose software solutions for capturing and analysis of signals from neural activity instead of to the study of specific problems of neurophysiology in different biological species, which shows the development of the candidate's interests over time. For example, the publication ML2012G in the prestigious specialized edition IEEE Transactions on Biomedical Circuits and Systems, which is among the

most cited works of the candidates, offers a hardware solution ASIC for recording multichannel neuronal signals in vitro and in vivo at high resolution and relatively low noise levels, while the W2013G applies a sorting algorithm action potentials in the analysis of such signals in deep brain stimulation for diagnostic and therapeutic purposes.

I do not have the necessary expertise to competently assess the significance of the original scientific contribution of the candidate in this field, so I trust instead the recommendation of his current employer, the Director of NERF, IMEC, and the fact that a large portion of his articles are accepted for publication in prestigious specialized journals (Q1) and generate a significant number of citations. This assessment also applies to the overall scientific work of Dr. Prodanov.

4. Technical and pedagogical skills

In the submitted documents there is no evidence of extensive pedagogical experience, except for the active participation in international conferences, summer schools and graduate courses. However, a number of technical competencies are indicated, such as working with specialized environments such as MATLAB, Mathematica, ImageJ and Maxima, practical experience with software architecture and databases and knowledge of four foreign languages.

5. Critical remarks

I have no significant critical remarks on the candidate's research work.

6. Personal impressions of the candidate

I know Dr. Prodanov from international conferences and summer schools in geometric algebras, over the years we have discussed different mathematical ideas. What makes a strong impression about him is his multidisciplinarity: the ability to combine, confidently and competently, areas of physics, biology and medicine, algebra and statistics, numerical methods and programming. He manages to transform abstract ideas easily into practical engineering solutions to specific problems, from which his research benefits a great deal. People in the scientific community value these qualities and in my estimate, he is deservedly accepted there with respect: as a lecturer and presenter, collaborator or interlocutor in a discussion. For this reason, I believe that he would actively contribute to the prestige and scientific production of the whole institute.

7. Conclusion

In view of all the above considerations, I am convinced that Dr. Dimitar Petkov's application for "associate professor" in the professional field 4.6. Informatics and computer science (image processing) **meets all requirements**. That is why I give my categorical **positive conclusion** and I strongly recommend that the Scientific Jury vote on the proposal to the Scientific Council of IICT-BAS **to elect** Dr. Prodanov as an associate professor in the present procedure.

Sofia,
03.12.2020

signature: ....

/ Danail Brezov /