OPINION

for the competition for occupation of the academic position „professor", in higher education area 4. Natural sciences, mathematics and informatics, professional field 4.6. Informatics and computer sciences, specialty „Informatics", declared in the State Gazette № 41/21.06.2019 for the needs of Department of Mathematical methods for sensor information processing at the Institute of Information and Communication Technologies-Bulgarian Academy of Sciences
Candidate: Assoc. Prof. PhD Petia Doicheva Koprinkova-Hristova

Member of the scientific Jury: Prof. PhD Alexandra Ivanova Granharova
University of Chemical Technology and Metallurgy, Department of Industrial Automation

I present this opinion as a member of the scientific Jury of the above mentioned competition on the base of order № 208 from 16.08.2019 of the Director of IICT–BAS, as well as on the ground of the decision of the scientific Jury (Protocol №1 from 28.08.2019). This opinion fully corresponds to the *Act for the development of the academic staff in the Republic of Bulgaria (ZRASRB)*, the *Regulations of the Council of Ministers (CM) for its applications,* the *Regulations for the development of the academic staff of BAS*, and the *Regulations for the specific conditions for awarding scientific degrees and occupying academic positions in IICT-BAS.*

1. General description of the presented materials.

I received the following documents of the candidate for participation in the competition: CV, copy of the PhD diploma, certificate for the length of service, certificate for awarded scientific title senior research fellow second degree, list of the scientific publications for participation in the competition, abstracts of the publications in Bulgarian and in English, copies of 46 publications and 1 textbook for participation in the competition, list of citations in Scopus and Web of Science of the publications for participation in the competition, list of citations in Scopus and Web of Science of the other publications, reference for the original scientific and scientific-applied contributions, list of the scientific and the educational projects, which the candidate has led or has participated in and the copies of the respective confirmation documents, checklist for the fulfillment of the minimal national requirements to become professor and the requirements in IICT-BAS, declaration for the absence of plagiarism.

The candidate Assoc. Prof. Petia Koprinkova-Hristova fulfills all the requirements stated in the *ZRASRB*, the *Regulations of the CM for its application*, the *Regulations for the development of the academic staff of BAS*, and the *Regulations for the specific conditions for awarding scientific degrees and occupying academic positions in IICT-BAS.* The presented scientific publications entirely correspond to the topic of the competition.

2. General characteristics of the candidate's scientific research, education and application activities.

Assoc. Prof. Petia Koprinkova-Hristova presents **46** scientific publications for participation in the competition. From them, **6** publications are in Impact Factor (IF) journals (3 articles in category Q1, 1 article – in Q2, 1 article – in Q3, 1 article – in Q4), **23** publications are in journals with Science Journal Rang (SJR), **17** publications are in edited volumes, which are refereed and indexed in the world secondary literature sources. Seven of the publications are single author, 7 have one co-author, 14 have two co-authors, and 18 are with more than two co-authors. In 18 of the joint publications Assoc. Prof. Petia Koprinkova-Hristova is the first author. For the criteria of **group B**, 15 publications are included, which makes **302** points (100

points being the necessary minimum). The publications presented in **group Г** are 31, resulting in **606** points (260 points being the necessary minimum). This clearly shows that the publication activity of the candidate significantly exceeds the minimal requirements of IICT-BAS. For the criteria of **group Д**, a list of 132 citations of the candidates's publications for the participation in the competition is presented, which makes **792** points (140 points being the necessary minimum). Another 36 citations of other candidate's publications are also listed. For the criteria of **group E**, an information is given about the international and the national scientific and educational projects led by the candidate, as well as an information about their budgets. The projects in which the candidate has participated in are also given. The **group E** includes also the textbook „Kinetics and control of the bioprocesses" co-authored by Assoc. Prof. Petia Koprinkova-Hristova and based on the educational program of the discipline „Kinetics and control of the bioprocesses" for the MSc students in the specialty „Biotechnology" from the University of Food Technologies in Plovdiv. Thus, the activities included in **group E** make **422,44** points (150 points being the necessary minimum).

From the analysis of the above information it follows that the candidate's activities in all groups of criteria significantly exceed the respective necessary minima.

It has to be mentioned that Assoc. Prof. Petia Koprinkova-Hristova has an active education activity that includes giving lectures and seminars in English on the discipline „Process control and industrial automation" at the Technical University-Sofia, branch Plovdiv, for a period of 4 academic years, as well as supervision of the educational practices of students within the project „Students practices – phase 1" of the Ministry of Education and Science. The plenary lectures presented by her by the invitation of the organizers of the prestigious international conferences 6-th International Symposium on Process Control, 2009 and 8-th International Conference on Electronics, Computers and Artificial Intelligence, 2016 prove that she is greatly respected by the international scientific community.

Assoc. Prof. Petia Koprinkova-Hristova has also a significant expert activity – she is a co-chair of the IEEE International Symposium on INnovations in Intelligent SysTems and Applications (INISTA 2013, INISTA 2016, INISTA 2019) and is a member of the organization/programme committees of 53 international scientific events. Assoc. Prof. Petia Koprinkova-Hristova is a co-editor of 2 scientific books, published by Springer and of 5 volumes of papers, presented at international conferences, as well as a guest-editor of the special issue of the International Journal on Reasoning-based Intelligent Systems in 2014, devoted to the innovations in the intelligent systems and their applications. She is a member of the editorial board of the journal „Automatic and informatics", published by the Union of Automatic and Informatics „John Atanasoff".

Assoc. Prof. Petia Koprinkova-Hristova has an active scientific-application activity that includes the coordination of and the participation in numerous research projects. She has led 2 national research projects and has been the leader of the Bulgarian team of 3 international projects with a total budget of 128 938 leva. She has participated in: 2 national education projects, 12 national scientific projects, 4 national research projects, 1 international scientific project, financed by the 7-th Framework Programme of the European Commission.

3. Analysis of the scientific and applied research results of the candidate.

The candidate's publications for participation in the competition contain significant scientific and applied achievements. Presented in a compact form, they are:

Scientific contributions:

1. Contributions in the field of heuristic dynamic programming by using neural networks, more specifically the Adaptive Critic Design (ACD) method by applying a new type of recurrent neural networks (Echo state networks - ESN), called briefly type „echo":

- An approach is developed for incorporating the dynamic ESN in the structure of the ACD being as the "actor" element (the learning agent or controller), as well as the „critic" element (the element that approximates the Bellman's equation and predicts the future values of the cost function) with the aim of increasing the training rate (solving the optimization problem).
- Two heuristic algorithms are proposed for training the „actor" element of type „echo" in the structure of the ACD, taken from the classical associative rules for the reinforcement learning.
- The stability of the "echo" type neural networks is theoretically studied and it is proved that the method of preliminary adjusting their reservoir of neurons according to the features of their input signals, called Intrinsic Plasticity tuning, or IP, improves their characteristics related to their stability.

2. Creation of spike timing neural (SNN) models for simulation of the human eyes movements.

- An SNN model of the human vision system is developed, which includes the main stages of vision information processing and decision making based on the perception. The model is implemented in the NEST simulator environment.
- The effect of model parameters changes is studied and their appropriate values are determined in order to solve the task of recognition of orientation and movement direction of moving objects with known dimensions.

3. Contributions in the field of neural networks and neuro-fuzzy approaches:

- An approach to solve optimization problems is developed by using the backpropagation of the cost function with time and it is applied to determine the optimal parameters of the membership functions and the union operation, defined as a parameterized T-norm, of a fuzzy controller for a nonlinear plant, simulated be a neural network model.
- A modification of RBF neural network is suggested by using intuitionistic fuzzy functions for the purposes of modelling of nonlinear relations.

4. Contributions in the field of fuzzy sets theory: A theoretical study is conducted of the influence of the parameters defining the shape of the membership functions on the fuzzy values of the linguistic variables of a fuzzy controller, as well as the effect of the parameters determining the fuzzy union operation in the form of a parameterized T-norm on the properties of the closed-loop system linear plant – fuzzy controller.

Scientific-applied contributions:

1. The developed ESN-ACD optimization scheme is applied to solving the following application problems: Control of a laboratory mobile robot; Determination of the optimal time profiles of the set-point values of the key variables in the control of a nonlinear biotechnological process for synthesis of a biodegradable polymer by increasing its efficiency; Determination of the optimal dilution rate profile of the fermentation process for producing bio-ethanol; Adaptive control of a distillation column; On-line adaptation of a Kalman filter for a micro-electro-mechanical sensor during changes in the device working conditions.

2. A research is conducted in order to choose an appropriate storage format of the experimental results related to the creation of the spike timing neural (SNN) models for simulation of the human eyes movements.

3. The developed approach to solve nonlinear optimization problems by using the backpropagation of the cost function is applied to: Determination of the optimal steel alloy composition to obtain the desired characteristics of the material used for crankshafts production; Determination of the optimal initial conditions of a periodic fermentation process.

4. Software sensors are developed which use layered feedforward neural networks for the on-line monitoring of non-measured variables of the Lysine fermentation process.

5. The neural networks of „echo" type are applied to: Obtain a model of the vibrational tendencies in a mill fan; Solve the word sense disambiguation problem.
6. The developed method for extraction of the characteristics of multi-dimensional data is applied to: Processing of multispectral satellite images; Processing of data from acoustic camera for rolling bearings noise measurement.
7. A fuzzy rules base is defined for the control of a biotechnological process with a mixed culture by using the available expert information for its optimal control. A fuzzy rules base is proposed for fusion of the measurements of two types of sensors – gyroscopes and accelerometers – in a micro-electro-mechanical sensor.
8. A comparative study is made of the application of genetic algorithms and fuzzy systems to the control of a nonlinear biotechnological process. The possibility to apply genetic algorithms for parameter identification of the models of plants in the oil-processing industry is studied.
9. Models of the batch alcoholic fermentation with free and immobilized cells of Saccharomyces cerevisiae strain 46 EVD are obtained using experimental data. A model of the batch fermentation process for yogurt starter culture formation is obtained by considering the effect of the dissolved oxygen.

4. Impact of the results achieved by the candidate on the scientific community.

The scientific and the scientific-applied contributions in the publications of the candidate are original and have a substantial significance for the science and the practice. In this respect, the listed 132 citations of the publications for participation in the competition show that the achieved significant results are well known and used by the scientific community in Bulgaria and abroad.

5. Conclusion.

Based on the analysis of the presented materials and by considering the significant scientific and applied research results, the teaching experience and the scientific-organizational activities of the candidate, all conducted at a very high level, I am convinced that they fully correspond to the requirements of the *Act for the development of the academic staff in the Republic of Bulgaria (ZRASRB)*, the *Regulations of the CM for its application*, the *Regulations for the development of the academic staff of BAS*, and the *Regulations for the specific conditions for awarding scientific degrees and occupying academic positions in IICT-BAS*. In relation with this, it has to be noted that the candidate's activities in all groups of criteria significantly exceed the respective necessary minima. **On the basis of all this, I give a high positive evaluation of the candidate and I am convinced in recommending to the honorable Scientific Jury to award the academic position „Professor" to Associate Professor PhD Petia Doicheva Koprinkova-Hristova in the professional field 4.6. Informatics and computer sciences, the scientific specialty „Informatics".**

Sofia
14.10.2019

Reviewer:
/Prof. Alexandra Grancharova, PhD/