STATEMENT

on the competition procedure
for occupation of the academic position „Associate Professor"
in the professional field 4.1. Physical Sciences („Physics of Wave Processes"),
published in State Gazette № 79 / 04.10.2022
with applicant PhD Branimir Ludmilov Ivanov
Assistant Prof. in the Institute of Optical Materials and Technologies "Acad. Jordan Malinowski",
Bulgarian Academy of Sciences

Prepared by: Assoc. Prof. Christina Andreeva, Institute of Electronics – Bulgarian Academy of Sciences

1. General characteristics of the submitted materials

The total scientific production of Assistant Prof. Dr Branimir Ivanov consists of 32 publications, of which 15 in journals with impact factor and 17 in journals with SJR. In the present competition Dr Ivanov applies with 24 publications (beyond those for obtaining the PhD degree), 11 of which are in impact factor journals and 13 scientific articles in journals with SJR.

For criterion A the applicant holds a diploma for the PhD degree, which meets the requirements of the law for 50 points.

Under criterion B the applicant presents 9 publications substituting the habilitation thesis, 3 of them in impact factor journals and 6 – in SJR journals. The applicant presents 104 points, with the minimum required score being 100 points.

Under criterion Г the applicant presents 15 publications, 8 of which in impact factor journals and 7 in journals with SJR. The total score for this criterion is 239, which exceeds the required minimum of 220 points.

The applicant has presented a list of 32 citations of his work in journals indexed in Web of Science and Scopus, thus the score under criterion D is 64 points, with a minimum required 60 points.

2. General characteristics of the applicant's scientific activity

Assistant Prof. Branimir Ivanov is the only applicant in the present competition for occupying the academic position "Assoc. Prof.". He has graduated from the Department of Quantum Electronics at the Faculty of Physics, Sofia University, obtaining a Master degree in 2000. He started working at the Institute of Optical Materials and Technologies and defended his PhD thesis there in 2013. He has three specializations (in the Russian Federation and in Italy). He has been a member of the team of 10 projects, 5 of them under European and international programs and funds, 1 under Operational Program of the Structural Funds and 3 with Bulgarian companies.

The research and applied activities of the candidate are mainly related to investigations in the field of interferometric systems, diffraction optics, digital holography and optical metrology. An extremely good impression is also made by the candidate's public and promotional activities related to planning, construction and participation in numerous national and international holographic exhibitions, participation in popular science television shows and publications. Part of the work on the candidate's projects is related to the improvement and production of holographic images for the purpose of preserving our national and world cultural heritage.

3. Main fundamental and applied scientific contributions

The main research investigations of the candidate are focused in five directions.

More specifically, the work related to interferometric methods for determination of the spectral parameters of light sources with noise correction is based on the developed three-channel correlation Fourier spectrometer with real-time tracking of the autocorrelation functions of LEDs, where the noise is analyzed by means of Monte Carlo simulations. To improve the accuracy, a feedback system is realized for ongoing correction of the autocorrelation of the working light source. The sensitivity of the interferometer to noise sources is estimated by recovering a single absorption peak for recording a signal and simulated noise. A method has been developed for processing of the recorded interferograms, for which the time for data recording and spectrum recovery is of the order of several seconds. This makes possible the real-time reconfiguration of the light sources and their application for studying of fast processes.

The work related to profilometric methods for remote determination of the shape and three-dimensional visualization of objects are based on the analysis of a sinusoidal phase grating generated by an 8-bit phase modulator. The distortions in the projected fringes due to phase quantization are analyzed. The simulation of free-space propagation shows decrease in the intensity fluctuations of the projected fringes for a $\pi/2$ phase modulator as compared to the 2π modulator. Reduction of the speckle in the interference fringes projected with a sinusoidal phase grating is demonstrated for low-coherence point LED source.

The third direction of investigations is related to the development of numerical methods for analysis of data from dynamic speckle measurements. The first method uses data compression by coarses quantization of the raw speckle images and its efficiency is estimated by means of processing of synthetic speckle images generated with high and low contrast. Conclusions have been drawn on the applicability of uniform and non-uniform quantization in these two cases. The results have been verified experimentally. Also, a point-wise processing of the dynamic speckle images is proposed, involving calculation of a normalized correlation-based score connected with the activity in each point of the sample. The high spatial resolution and reliability of the method for inhomogeneous distribution of the light beam and different reflectivity of the sample surface have been evidenced by means of simulation and experimentally. The third proposed method is a dynamic speckle analysis method for non-destructive detection of physical and biological activity by means of conversion of the speckle images into binary images with only two levels and introduction of a threshold value. The method has been verified by simulation and experiment both for homogeneous and inhomogeneous distribution of the intensity of the illuminating light beam without normalization. Proposed is also a method for improving the quality of determination of the two-dimensional distribution of the rate of processes (activity map) taking place on the surface of diffusely reflecting objects using the varying speckle image and filtering this distribution, which yields similar contrast and resolution of the activity map. The possibility for testing the algorithms by a phase spatial optical modulator as an optical simulator of speckle images with controllable time evolution has been confirmed.

Besides these analytical investigations, an important aspect of the work is its applied focus, namely for monitoring and control of specimens and drying processes by means of dynamic specle analysis. More specifically, the dynamic speckle analysis has been applied for determination of the change in the rate of processes taking place due to humidity and chemical influence on plant leaves in two test experiments. Another application area is the monitoring of the process of cooling and aging of bread. An approach to improve the visualization of areas of changes on the surface of a diffusely reflective object by exponentially decreasing temporal correlation function of the intensity fluctuations is also proposed, which was applied and validated in an experiment on paint and azopolymer solutions drying.

Regarding the direction of work related to holographic and interferometric methods for sample visualization and control, the generation of 3D input digital data has been analyzed for two types of holographic printers used for printing of analogue reflection holograms of cultural artefacts. A holographic wavefront printer is proposed for creating real volume holograms by digital input data in the form of 2D arrays representing computer-generated holograms. This provides high reproduction realism and a possibility to enlarge and zoom into the object. A method has been proposed for accelerated computation of the input data, and its printing quality is demonstrated by printed colour holograms.

The possibility for application in materials science for precise measurement of the mechanical stress field in a specimen with photo-elastic coating has been shown by means of a proposed and developed polariscopic and holographic phase-shifting system with a coherent light source. Since the phase extraction is compromised by speckle noise, a simulation of the phase-shifting photo-elastic measurement in the presence of speckle noise was done in a Mach-Zender interferometer and circular polariscope configuration, with subsequent filtering and normalization of the interference fringe patterns. This has been shown to result in acceptable phase retrieval accuracy for isochromats and isoclines.

4. Critical remarks and recommendations

I have no critical remarks but I would point out at the large number of the contributions formulated by the candidate, which in my opinion could be thematically grouped. Also, I would recommend that in the list of publications presented for the competition, the personal contribution of the candidate is clearly indicated. These comments are only technical and are not connected to the quality of the work. I am firmly convinced that Dr Branimir Ivanov is a well-established specialist in the field of wave optics, with proven skills in the development and application of numerical models and simulations, as well as in experimental studies.

5. Conclusion

Based on my acquaintance with the materials presented for the competition, the relevance and important impact of the fundamental and applied contributions, I recommend the positive decision of the jury to support Dr Branimir Ivanov to take the academic position Assoc. Prof. at professional field 4.1. "Physical Sciences" (Physics of Wave Processes) at the Institute of Optical Materials and Technologies.

Date:

26.01.2023 г.

Signature:

/C. Andreeva/