S.B. Popov, Doctor of Engineering (Commemorating the 60th Birth Anniversary)

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Abstract

The paper focuses on key scientific and academic accomplishments of Sergei Borisovich Popov, Doctor of Engineering.

Keywords: Doctor of Engineering; scientific research automation; computer vision; computer vision system; parallel image processing; distributed Big Data processing

1. Introduction

This year Sergey Borisovich Popov, Doctor of Engineering, leading researcher of the Laboratory of Mathematical Methods of Image Processing of the Image Processing Systems Institute of the Russian Academy of Sciences (IPSI RAS) – the Branch of the "Crystallography and Photonics" Federal Research and Development Center of the RAS (FRDC RAS), and in addition to his other duties, professor of the Department of Engineering Cybernetics of S.P. Korolyov Samara National Research University is celebrating his 60th Birth Anniversary. The paper focuses on key scientific and academic accomplishments of S.B. Popov.

2. Kuibyshev Aviation Institute

In 1981, S.B. Popov graduated the Faculty of Systems Engineering of Kuibyshev Aviation Institute named after academician S.P. Korolyov (KuAI, currently – S.P. Korolyov Samara National Research University) majoring in Applied Mathematics. He worked at KuAI from 1981 (in 1992 the Institute was renamed into S.P. Korolyov Samara State Aerospace University, SSAU) first in the capacity of an engineer and then – a senior engineer and a junior researcher. From January 1993 till December 1998, he worked in the capacity of a teaching assistant at the Department of Engineering Cybernetics at S.P. Korolyov Samara State Aerospace University (SSAU, formerly KuAI).

His graduate thesis was related to the research in which he was engaged over a long period of his activity and to which he still continues to pay much attention, i.e. scientific research automation using computer vision techniques. Within the framework of joint activities with A Department of Lebedev Physical Institute of the USSR Academy of Sciences (LPI RAS), he has developed new software for the Automated control system for spherical optical surfaces (ACSOS) "Shadow" [1, 2].

Being a part of the Research and Development Laboratory of KuAI-SSAU, he participated in the development of algorithmic and software support of the image processing system based on the PC image processing automated system [3-6].

In his research S.B. Popov developed methods of efficient organization of computing processes in image processing which paralleled these processes by combining sequence image operations into a pipeline [7-9]. These studies provided the basis for his Ph.D. thesis in Engineering "Modeling of Data Stream Processing Networks and Methods of Organizing Two-Dimensional Data Sets in Image Processing." The thesis has presented efficient methods of image stream processing in PC-based computing systems and developed image processing software tools based thereon combining high performance of Big Data processing, relatively low value, scalability, feasibility in development and implementation of new software modules, and high adjustability to different formats of storing images. The Candidate degree in Engineering was conferred by the Dissertation Council of S.P. Korolyov Samara State Aerospace University (SSAU) on May 15, 1998 and approved by the State Higher Attestation Committee of the Russian Federation on November 20, 1998.

3. Image Processing Systems Institute of the Russian Academy of Sciences

From August 1998, S.B. Popov has moved to the Image Processing Systems Institute of the Russian Academy of Sciences (IPSI RAS) [10] where he has been working until present first in the capacity of a senior researcher and then, from 2013, as a leading researcher.

From 2000, he was actively involved into development of the Regional Center of High-Performance Information Processing in Samara Scientific Center of the Russian Academy of Sciences (SSC RAS) [11], developed applied software for parallel multivariable data processing on high-performance computers for scientific research in the field of Computer Optics [12,13] and Image Processing [14,15], and provided support to educational process in training programs associated with training of specialists in the field of parallel high-performance computing [16-19].

S.B. Popov's research interests have gradually expanded in the following research areas: Big Data Image Processing [20], Mathematical Modeling of Parallel Computing, and Software for Distributed and Parallel Systems, in particular, Applied Software for High-Performance Computers [21-25].

Additionally, S.B. Popov is fully engaged in developing automation systems for complex research and tests, and in building original computer vision systems both in traditional applications (for recognition of identification numbers of railway tanks) and for unique laboratory investigations [26, 27].

In particular, under the guidance and with the active involvement of S. B. Popov, the following software tools have been developed: Automated System of Data Control, Collection and Processing in Experiments in a Wind Tunnel with a Climate chamber dynamometer in the Technical Development Directorate of JSC AVTOVAZ (Togliatti, 2002-2003), Railway Tanks Registration System in Samara-Terminal Ltd. (Syzran, 2004-2005), Computer Vision System to Control Laboratory Analysis on Quantifying Gel Particles in Polymer Solution in Kuibyshevazot company (Togliatti, 2005), Automated Computer Vision System to Control Identification Numbers of Tank Wagons in JSC Ufa Refinery (Ufa, 2008-2009), and up-grading a control system with an all-wheel drive chassis dynamometer system by Schenck in a wind tunnel (2012) for the Research and Development Centre of JSC AVTOVAZ (Togliatti).

Scientific tasks for building mathematical models and control algorithms for the all-wheel drive chassis dynamometer system by Schenck [28] and complex humidity- and temperature-control systems, being a part of the wind tunnel for testing light motor vehicles, LCVs and minivans, have been successfully solved in applications developed for the Research and Development Centre of JSC AVTOVAZ.

When creating computer vision systems for Samara-Terminal and Ufa Refinery, some original algorithms have been developed for recognition of identification numbers [29, 30] on such complex moving objects as tank wagons for transportation of contaminated crude oil and fuel oil under daylight and artificial daylight conditions with significant changes in surveillance parameters within 24 hours and throughout the year depending on a season [31-34].

New methods of thresholding and analysis of binary images being obtained therewith have been developed for the computer vision system required for laboratory tests on quantifying gel particles in polymer solution for Kuibyshevazot company that operate under conditions of a weak image-contrast ratio and in presence of considerable disturbances [26, 35]. The system used instead of an observer while carrying-out this analysis has reduced dramatically a psychovisual load on lab staff, provided documenting capability of performed lab testing, and improved accuracy and certainly of quantifying gel particles in polymer solution that finally helped adjust a process of manufacturing industrial threads and cord fabrics.

The successful implementation and long-term operation of the above mentioned computer vision systems [36, 37] are based on a human-operator base priority principle. Computer vision capacity provided therein doesn't remove the operator out of the system, but it makes him released from stress associated with the fear not to notice anything or not to manage with fixing an important event in monitoring a long-lasting dynamic process, thus providing a convenient environment for visual control and editing of an automatically generated list of tanks or fragments of occurring inhomogenuity of the laboratory analysis process.

Projects designed with the involvement of S.B. Popov have found use and successfully operated in the Central Specialized Design Bureau "Progress," FIAT Research Center (Italy), Intel (USA), and LG (South Korea) and are currently used in academic activities of Samara University.

In his scientific research S. B. Popov brings up one of the most important issues in using IT-equipment – mapping of computational mathematics problems onto the architecture of computing systems which was identified by academician G.I. Marchuk as a fundamental academic research area briefly called a mapping issue.

In particular, solving the issue of imaging computational problems onto the parallel or distributed architecture of computing systems is the most relevant issue since a focus area in improving the efficiency of the use of computing facilities is the use of parallel computing techniques [38]. The basic approach to solve the imaging issue is the analysis of a computational problem that identifies parallelism and opportunity to use distributed data and is performed on the basis of mathematically equivalent transformations of an information structure model of the solution algorithm for the problem being investigated or, more generally, of an IT model for solving the problem.

Particularly this very approach was used by S.B. Popov [39, 40] in his Doctoral thesis "Modeling and development of the structure of distributed large-size image processing systems based on the dynamic organization of data" in profile 05.13.18 – Mathematical Modeling, Numerical Computing and Software Systems (consultant – Corresponding Member of the RAS V.A. Soifer [41]), which was successfully defended at the end of 2010 in the Dissertation Council of SSAU. The thesis based on the dynamic management method, processing iterator models, and equivalence transformation rules has solved the problem of modeling and structuring of distributed image processing systems with different types of parallelism. A set of obtained scientific results is to be the solution of the fundamental scientific problem – the mapping issue for a widely used class of problems of mathematical image processing. He took his Doctoral degree in Engineering in 2011.

For the time being, in his papers S. B. Popov investigates characteristic features of the Earth's remote sensing data in the frame of Big Data and new opportunities, challenges, and research areas arising therefrom [42], considers advantages of using the Big Data technique when building distributed systems for processing multidimensional spatially dependent data, in particular, transparent expansion of functionality of such systems and improvement of their quality [43], and definition of new smart properties [44].

S.B. Popov took part in implementation of dozens of grants, state-financed and contractual research projects and was an authorized person responsible for several large research and development projects. He is also a leader of some grants financed by the Russian Foundation for Basic Research.

The projects designed with the involvement of S.B. Popov were exhibited at the Russian National Exhibition in China (November 8-13, 2006, Beijing) and were awarded with certificates of the First and Third District Exhibitions of Business Angels and Innovators (2003 – Nizhny Novgorod, 2005 – Samara).

He is the author or co-author of more than 100 research papers, including three monographs and 25 articles in the leading journals, such as Technical Physics, Automation in Industry, Pattern Recognition and Image Analysis, Computer Optics, etc., and 5 invention certificates received. S. B. Popov is one of the most active reviewers of the scientific journal “Computer Optics” [45, 46]. Besides, thanks to his efforts and based on the results in 2015, the journal has joined the rank of the best half (the second quartile) of the journals indexed in the Scopus database in its all focus areas.

In 2013, S. B. Popov was awarded with the Letter of Acknowledgement of Samara Regional Duma (regional legislative body) “For Strong Contribution to Development of the Federal State Budgetary Institution of Education – Image Processing Systems Institute of the RAS.”

Popov S.B. was the winner of the regional Science and Technology Award in 2014 for his research work "Development of computer vision systems for the automation of high-tech manufacturing and logistics facilities in Samara Region".

Fig. 1. Sergei Bolrisovich Popov at the True Positive Conference.

4. Teaching activities

S.B. Popov successfully continues his employment at the academic institute alongside with his teaching activities – from January 1999 he was also employed as an assistant professor of the Department of Engineering Cybernetics, SSAU, and since 2011 he has been working in the capacity of a professor of the Department of Engineering Cybernetics, SSAU.

He was awarded with the academic title of an associate professor of the Department of Engineering Cybernetics, SSAU, in accordance with the order of the Federal Education and Science Supervision Service of the Russian Federation dated 26 October 2006 No. 2212/1179-D.

S. B. Popov pays great attention to students and young researchers’ engagement in scientific activities; the diploma theses of his advised students were recognized as the best ones many times [6, 47].

In particular, he (co-authored) has written five chapters of the monograph “Methods of Computer Image Processing” successfully gone into two editions in 2001 and 2003 [48] in the Publishing House “Fizmatlit” (Moscow) and recommended by the Ministry of Education of the Russian Federation as a study guide for students who learn Applied Mathematics. In 2010, the monograph was supplemented with new chapters and translated into English [49, 50].

In 2006, on request of the SSAU’s Innovative Educational Program “Development of the Center of Excellence and Training of World-Class Specialists in Aerospace and Geoinformation Technologies” implemented within the framework of the Education National Priority Project, 4 manuals for graduate students were published [51-54].

New lecture courses developed at different times, such as Network Programming Techniques, Parallel Programming, Parallel Programming Software Tools and Technologies, Data Mining, Big Data Processing Methods and Techniques (in the framework of the Professional Development Programme) should be noted, too.

5. Conclusion

In conclusion, I would like to wish Sergei Borisovich Popov good health, high performance, and talented students in order to continue his research and to obtain new results!

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