ON THE 50TH BIRTHDAY OF PAVEL G. SERAFIMOVICH

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Abstract. The article briefly describes the scientific and pedagogical achievements of associate professor, candidate of physical and mathematical sciences Pavel Grigorievich Serafimovich.

Keywords: candidate of physical and mathematical sciences, cloud computing, video streams analysis, high-performance computing, diffractive optics, photonic crystals, nanoresonators, nanophotonics.

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Introduction

On January 21, 2016 candidate of physical and mathematical sciences, senior researcher of the Image Processing Systems Institute of the Russian Academy of Science, and concurrently associate professor of technical cybernetics department of Samara National Research University Pavel Grigorievich Seraphimovich celebrated his fiftieth anniversary. The article briefly describes the scientific and pedagogical achievements of P.G. Serafimovich.

IPSI RAS

In 1989 P.G. Serafimovich graduated from the faculty of systems engineering of Kuibyshev Aviation Institute (now Samara National Research University) in applied mathematics specialty. After graduation he started working as an engineer-programmer at the Samara branch of the Central Design Bureau of Unique Instrumentation of the USSR Academy of Sciences, which in 1993 was transformed into Image Processing Systems Institute (IPSI RAS) [1-2]. Since 1993 P.G. Serafimovich has been a junior researcher, since 1994 - a researcher, and since 2002 - a senior researcher of IPSI RAS.
In 1997 he defended his candidate thesis “Analysis of iterative methods for computing phase functions of diffractive optical elements”, under the guidance of professor V.V. Kotlyar. In 2016 P.G. Serafimovich submitted to protection his doctoral thesis

“Computation and modeling of photonic-crystal coupled-resonator optical waveguides”, on the specialty 01.04.05 “Optics”. Currently P.G. Serafimovich has got 35 Scopus publications, his Hirsch index is 7.

Fig. 1. Pavel Grigorievich Serafimovich

Samara University

P.G. Serafimovich combines scientific activity with teaching work. Since September, 1995 P.G. Serafimovich has been working part-time at the department of technical cybernetics of Samara University as an associate professor. P.G. Serafimovich reads lectures on courses “Software of Multiprocessor Computer Systems” and “Grid Technologies and Cloud Computing”, he conducts practical and laboratory classes in these courses for students studying in the areas of applied mathematics and computer science and of applied mathematics and physics. He also supervises research work of bachelors and masters. Since that time he has prepared a textbook [3].

Main scientific results

The first scientific results were obtained by P.G. Serafimovich under the guidance of professor V.V. Kotlyar and were focused on iterative methods for calculating diffractive optical elements (DOEs) [4-14]. The developed methods allow to increase the energy efficiency of DOE, at the same time improving the quality of their work. For example, for focusators the methods allow to reduce the mean square deviation of the intensity distribution obtained from the required one. In subsequent years P.G. Serafimovich used the obtained foundation for creating methods of investigating a variety of DOEs in the framework of asymptotic methods and computational experiment [15-20].

At the same time P.G. Serafimovich pays great attention to development of software [21-32]. He is involved in creating software products designed to calculate elements of computer optics [21-22], for modeling diffractive nanophotonic devices [25, 26, 31]. At the same time he makes extensive use of the opportunities offered by cloud technologies [25, 26, 31], high-performance and parallel computing technologies [23-24]. In these articles he proposed a parallel algorithm for calculating nanophotonic elements that implements the method of Fourier modes. He transformed the computationally intensive algorithm into an intensive algorithm for data processing. The use of the proposed approach on clusters built on the MapReduce technology allows to make efficient use of the intermediate data larger than 1 TB and to increase significantly the average time between failures of computing cluster nodes (Mean-Time-Between-Failures (MTBF)).

I would also like to highlight the results he gained in the field of intellectual analysis of video streams [28, 29, 32] and in development of methods for classifying hyperspectral images [27, 30].

From 2002 to 2006 Serafimovich worked in South Korea at the Samsung Advanced Institute of Technology. In this institute he took part in development of several illuminating and laser systems [33, 34], which were patented in the USA [35, 36].

The resulting scientific basis allowed him to start preparing his doctoral thesis. As part of these studies he received a number of interesting results, which are widely published and patented [37-57].

1. He proposed, computed, and numerically investigated a compact integrated on-chip nanophotonic element for integration of optical signals [46, 48, 49, 54]. The novelty is that for integration of various orders of optical signals he proposed to use a photonic crystal (PC) nanobeam cavity. This allows to increase compactness of the device dozens of times in comparison with existing analogues. As compared, for example, with ring resonators, large size of the free spectral band (210 nm) allowed integrating the impulses with width in the range of 150-200 femtoseconds at a wavelength of 1.55 microns with a mean square error of less than 10%.
2. He proposed, computed, and numerically investigated a compact integrated on-chip nanophotonic element for differentiation of optical signals [42, 44]. The novelty consists in the fact that he suggested to use a FC nanobeam cavity for optical signals differentiation. The dimensions of the proposed differentiator are ~ 6,0 × 0,5 × 0,2 microns for a wavelength of 1.55 microns. These dimensions are an order less than the existing analogues.
3. He offered, computed, and numerically investigated a compact FC nanobeam cavity having a quality factor above 105. The novelty is the use of two-components resonator structure [40, 51], which allows for the first time to implement a vertical electronic pumping of the resonator.
4. He proposed, computed, and numerically investigated intersecting FC nanobeam cavity with increased mode overlap coefficient [41, 57]. The novelty consists in using a slit resonance chamber, allowing to increase tens of times the energy density of the electromagnetic field in overlapping area of resonance modes.
5. He proposed, computed, and numerically explored a compact optical modulator based on a cascade of two FC resonators [53, 56]. The novelty consists in the ability to scale both the amount of pumping energy and the magnitude of spectral shift of the resonance mode. New is also that the proposed modulator allows to imple-

ment modulation in the field of small (less than 10% of peak value) intensity of the resonance mode.

6. He proposed, calculated, and numerically explored a compact optical sensor based on a cascade of two FC resonators [52, 55]. The novelty is the possibility of increasing twice the quality factor of the optical resonance system, thus increasing the sensitivity of the optical sensor.

Conclusion

In conclusion we would like to wish P.G. Serafimovich to have talented students who would continue and expand his scientific research, and successful defense of his doctoral dissertation!

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