

HOLOGRAPHIC TECHNOLOGIES (COLLECTION OF PAPERS BASED ON REPORTS AT THE HOLOEXPO 2019 CONFERENCE)

https://doi.org/10.1070/QEL17393

Research on holography in Russia

S.B. Odinokov, V.Yu. Venediktov

The development and application of photonic technologies is currently one of the priority directions in scientific and technological progress. An important part of current work on photonics is research and development in the field of optical holography. In recent years, both in Russia and abroad a great deal of attention has been paid to active incorporation of holographic methods and technologies into a great diversity of scientific research and practical application areas.

This can be exemplified by the development of protective holography with 3D colour images, application of holographic and diffractive optical elements (HOEs and DOEs) in 3D displays and imaging systems (virtual and augmented reality glasses), the use of computer synthesis of holograms for information display and in image holography and many other issues.

According to leading experts and scientists, several global trends and topical directions in the scientific and technological development of optical holography have been formed in the last decade (2010–2020). Note the two most important among them:

1. Digital holography, whose advent was due to technological advances in the fabrication and implementation of novel large photomatrices (CMOS structures) having up to 10^8 pixels 1–2 μm in size, which enabled real time recording of 'live' interference patterns: structures up to 20×20 mm in dimensions, with spatial frequencies of up to 500 mm^{-1}, and up to 1000 mm^{-1} in the future. This offers the possibility of getting rid of photosensitive materials and employing digital holography methods directly for recording amplitude–phase information about optical fields in the visible, IR and terahertz spectral regions. The incorporation of digital holography methods e.g. into optical microscopy in biomedical cell research allowed for real time imaging and investigation of cells in their natural habitat; determination of their size, shape, orientation and spatial position in the bulk; identification of micro- and nanoparticles; and observation of their 3D images on displays.

2. Computer synthesis of holograms. The advent of mathematical methods for digitising interference fields and computer synthesis of holograms and the design and practical implementation of megapixel spatial light modulators (based on liquid crystal structures or micromirror arrays) allowed computer-synthesised holograms (CSHs) forming optical wavefronts of required quality and essentially any complexity (flat, spherical, aspherical etc.) to be introduced in real time into the optical channels of instruments and systems.

Also there is still great interest in

(1) the development of holographic colour 3D volume images with elements of motion and dynamics for protective holography;

(2) the development and fabrication of a new generation of holographic wavefront sensors, including those based on Fourier holograms and spatial light modulators, which allows accuracy in laser beam wave aberration measurements to be improved to $\sim\lambda/50$;

(3) the development of HOE-based optical information display devices and 3D displays (at present, more than a hundred institutions deal with 'holographic' glasses and augmented reality (AR) indicators, with annual investment reaching US$100 million); and

(4) broad implementation of CSHs for use in image holography, which led to the advent of mobile laser systems for recording colour holograms of unique history and art objects by the Denisyuk method, with the possibility of rapidly delivering them to museums and exhibitions.

All these research directions are actively contributed by scientists and experts from over 20 laboratories and companies in Russia. They present their results at many international conferences and exhibitions, including the HOLOEXPO science and technology conferences, held annually in Russia, which allow one to understand the state of the market for holographic products, assess the level of cutting-edge scientific and technological projects in the field of holography and find out the key directions in its development.

This issue of Quantum Electronics presents a collection of 11 papers based on reports at the HOLOEXPO 2019 Conference, which illustrate the state of research on holography in Russia.

The editors of this issue are deeply grateful to all the contributors for their immense help in preparing the papers. Additional information about HOLOEXPO exhibitions can be found at http://holoexpo.ru.

S.B. Odinokov Bauman Moscow State Technical University (National Research University), Vtoraya Baumanskaya ul. 5, 105005 Moscow, Russia; e-mail: odinokov2009@yandex.ru;
V.Yu. Venediktov St. Petersburg Electrotechnical University LETI, ul. Prof. Popova 5, 197022 St. Petersburg, Russia; e-mail: vlad.venediktov@mail.ru

Received 1 June 2020
Kvantovaya Elektronika **50** (7) 613 (2020)
Translated by O.M. Tsarev