Applied Physics B (2022) 128:198
https://doi.org/10.1007/s00340-022-07921-9

Applied Physics B
Lasers and Optics

EDITORIAL

Advanced optical holographic imaging technologies

Vijayakumar Anand[1,2] · Tatsuki Tahara[3] · Woei Ming Lee[4]

Received: 5 October 2022 / Accepted: 5 October 2022 / Published online: 12 October 2022

Holography technologies have been rapidly evolving in the recent years due to surprising crossover of concepts and methods across different fields. This special issue was planned to capture some of the latest advances in the broad area of holography. We received contributions from leading researchers across the globe on all the important facets of holography technologies with a total of 85 authors. One of the significant aspects of this special issue is the roadmap type articles on two main branches of holography and imaging, namely incoherent digital holography (IDH) [1] and chaos-inspired imaging technologies (CI^2-Tech) [2].

The roadmap on IDH covered all the important subfields with a valuable historical overview of development connecting all the subfields with technology and time. In this roadmap, many top researchers contributed in their respective specialty areas: the basic principles and milestones of optical scanning holography by *Zhang* and *Poon*, Fresnel incoherent correlation holography and coded aperture correlation holography (COACH) by *Rosen* and *Anand*, compressive computational imaging with Fresnel zone aperture by *Wu* and *Cao*, application of phase-shifting interferometry technique to IDH by *Tahara, Koujin, Matsuda*, *Ishii*, *Kozawa, Okamoto*, and *Oi*, 3D infinite depth of field imaging using bimodal IDH by *Nobukawa*, holographic camera using geometric phase lens and 4-pol camera by *Choi*, 3D radiometric temperature measurement using IDH by *Imbe* and high-speed 3D motion picture by *Tahara, Kozawa, Ishii, Okamoto, and Oi*, were presented. We believe that this will be a useful material for a freshman to quickly understand the area of IDH and for an expert to review the future challenges [1].

The roadmap on CI^2-Tech is fundamentally different from IDH as this area "CI^2-Tech" has been newly identified as an area of interest in this special issue due to myriad of publications on this topic recently. Chaos has always been seen as a problem to be minimized if not eliminated in most areas of research. In the recent years, imaging technologies which exploit chaos as a means to enhance imaging capabilities is on the rise. Surprisingly, these techniques were not only powerful but also diverse in methods and applications. Like the roadmap on IDH, the roadmap on CI^2-Tech also received contributions from leading researchers across the globe. In this roadmap, both fundamental and applied research was contributed by the researchers: interferenceless COACH by *Rosen*, COACH with synthetic point spread functions by *Rosen, Anand and Juodkazis*, optical imaging through turbid media by *Xie, Liu, Liang* and *Zhou*, microscopy with chaotic light with regular and single pixel camera and extended depth of imaging through scatterers by *Osten, Ludwig, Pedrini, Schindle, Singh*, and *Takeda*, amplitude and phase imaging with random light by *Rakesh Kumar Singh* and *Sarkar*, quantitative phase imaging using incoherent light by *Baek, Hugonnet, Lee,* and *Park*, deep learning aided imaging through turbid media by *Yang* and *Situ*, speckle correlation based imaging and learning based focusing and imaging by *Horisaki* and super-resolution deep imaging with speckle illumination by *Aguiar* and *Gigan* [2].

The other articles published in the special issue were diverse and exciting. The research group led by *Juodkazis – Smith, Ng, Han, Katkus, Anand* and *Glazebrook*, reported an interdisciplinary research work connecting computational imaging and advanced manufacturing [3]. The research group led by *Forbes* consisting of *Rodríguez-Fajardo, Guzman, Mouane,Wamwangi, Sideras-Haddad* and *Roux*

✉ Vijayakumar Anand
vijayakumar.anand@ut.ee

1 Optical Sciences Centre and ARC Training Centre in Surface Engineering for Advanced Materials (SEAM), School of Science, Swinburne University of Technology, Hawthorn, VIC 3122, Australia

2 Institute of Physics, University of Tartu, W. Ostwaldi 1, 50411 Tartu, Estonia

3 Applied Electromagnetic Research Center, Radio Research Institute, National Institute of Information and Communications Technology, 4-2-1 Nukuikitamachi, Koganei, Tokyo 184-8795, Japan

4 Optical Biofluidics Imaging Group, The John Curtin School of Medical Research, ANU College of Health and Medicine, Australian National University, Canberra, Australia

reported a novel interferometry-based topography measurement method that is capable of measuring reflective as well as partially reflective surfaces [4]. A rapid computer generated holography calculation method based on deep learning was reported to overcome the limitations of Gerchberg-Saxton algorithm by the research group led by *Ito—Ishii, Shimobaba, Blinder, Birnbaum, Schelkens* and *Kakue* [5]. The research group led by *Awatsuji—Inoue, Sasaki, Nishio,* and *Kubota* presented a useful numerical analysis of light-in-flight holography systems [6]. Wavefront analysis in in-line and off-axis holography configurations with a plane wave and conical wave have been compared with a deep learning network by the research group led by *Petrov—Khonina, Khorin, Serafimovich, Dzyuba* and *Georgieva* [7]. The performances of de-noising algorithms from the point of noise statistics have been analyzed by *Montrésor* and *Picart* [8]. The research group led by *Kumar—Dwivedi, Pensia,* and *Singh* reported an interesting application of a portable digital holographic camera to inspect the wear of machine tools [9]. The research group led by *Ferraro—Sirico, Miccio, Wang, Memmolo, Xiao, Che*, *Xin* and *Pan* presented an extensive research on strategies to minimize aberrations in holographic microscopy systems [10]. *Mirsky* and *Shaked* reported single shot six-pack holography technique that enables acquisition of six off-axis holograms with improved field of view [11].

We believe that the collection of articles in the special issue will be treasured in holography. We also hope that this special issue will be useful in understanding the latest developments in the area of holography. Before we conclude, we express our sincere thanks to the leading researchers and authors who contributed to the special issue. We thank Cindy Zitter, Fabio Santos and Malwina Strenkowska for their invaluable support. Above all we thank the Editor-in-Chief, Jacob I. Mackenzie of Applied Physics B who has offered his continuous support, encouragement, strategic advices and guidance from the beginning—pre-announcement of the special issue to the current date. Happy Reading!!!

1. Assoc. Prof. Jacob I. Mackenzie (Editor-in-Chief of *Applied Physics B*)

We are very proud of our Collections series in *Applied Physics B*, they provide a focused snapshot of present and past in their topics, a fabulous information source for scientists to come back to when wanting to reprise themselves of the state of the art in the field. This special issue is no exception, it contains two Roadmap feature articles that set out visions for imaging methodologies that will inspire readers to push into new frontiers. These papers are aptly supported by the accompanying contributed papers heralding key advances in various holography and imaging modalities. I'd personally like to congratulate the Editors of this collection and hope our readers benefit from the pearls of knowledge therein.

2. Prof. Peeter Saari (Emeritus Professor, Institute of Physics, University of Tartu)

Without doubt, this special issue is interesting and useful both for researchers who work in the field of holography and imaging, as well as for PhD students specializing in these fields. But in addition, those who, like me, have dealt with holography at some earlier point in their research careers will also find it enjoyable to read and realize what a tremendous development this field has undergone.

3. Prof. Aydogan Ozcan (Chancellor's Professor and HHMI Professor, UCLA)

This is a very exciting special issue on holographic imaging field, which has been going through a true renaissance over the last several years, driven by machine learning and the optimization tools behind deep learning. I believe the readers will very much enjoy going over these recent contributions to holography and its applications to imaging.

References

1. T. Tahara, Y. Zhang, J. Rosen et al., Roadmap of incoherent digital holography. Appl. Phys. B. **128**, 193 (2022). https://doi.org/10.1007/s00340-022-07911-x
2. J. Rosen, H.B. de Aguiar, V. Anand et al., Roadmap on chaos-inspired imaging technologies (CI2-Tech). Appl. Phys. B **128**, 49 (2022). https://doi.org/10.1007/s00340-021-07729-z
3. D. Smith, S.H. Ng, M. Han et al., Imaging with diffractive axicons rapidly milled on sapphire by femtosecond laser ablation. Appl. Phys. B **127**, 154 (2021). https://doi.org/10.1007/s00340-021-07701-x
4. V. Rodríguez-Fajardo, C. Rosales-Guzmán, O. Mouane et al., All-digital 3-dimensional profilometry of nano-scaled surfaces with spatial light modulators. Appl. Phys. B **127**, 145 (2021). https://doi.org/10.1007/s00340-021-07691-w
5. Y. Ishii, T. Shimobaba, D. Blinder et al., Optimization of phase-only holograms calculated with scaled diffraction calculation through deep neural networks. Appl. Phys. B **128**, 22 (2022). https://doi.org/10.1007/s00340-022-07753-7
6. T. Inoue, M. Sasaki, K. Nishio et al., Numerical analysis of reconstructed image of light-in-flight recording by holography with a magnifying optical system. Appl. Phys. B **128**, 53 (2022). https://doi.org/10.1007/s00340-022-07773-3
7. S.N. Khonina, P.A. Khorin, P.G. Serafimovich et al., Analysis of the wavefront aberrations based on neural networks processing of the interferograms with a conical reference beam. Appl. Phys. B **128**, 60 (2022). https://doi.org/10.1007/s00340-022-07778-y
8. S. Montrésor, P. Picart, On the assessment of de-noising algorithms in digital holographic interferometry and related approaches. Appl. Phys. B **128**, 59 (2022). https://doi.org/10.1007/s00340-022-07783-1
9. G. Dwivedi, L. Pensia, O. Singh et al., On-machine tool wear estimation using a portable digital holographic camera. Appl. Phys. B **128**, 77 (2022). https://doi.org/10.1007/s00340-022-07795-x
10. D.G. Sirico, L. Miccio, Z. Wang et al., Compensation of aberrations in holographic microscopes: main strategies and applications. Appl. Phys. B **128**, 78 (2022). https://doi.org/10.1007/s00340-022-07798-8
11. S.K. Mirsky, N.T. Shaked, Dynamic three-wavelength imaging and volumetry of flowing cells with doubled field of view by six-pack holography. Appl. Phys. B **128**, 92 (2022). https://doi.org/10.1007/s00340-022-07812-z

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.