TECHNISCHE UNIVERSITÄT CHEMNITZ

ШУТИС

INTERNATIONAL SUMMER SCHOOL ON COMPUTER SCIENCE, COMPUTER ENGINEERING AND EDUCATION TECHNOLOGY 2018

Proceedings of the ISCSET-2018 workshop

(Novosibirsk, Russia, 12-18of August)

NOVOSIBIRSK

2018

The Ministry of Education and Science of the Russian Federation

NOVOSIBIRSK STATE TECHNICAL UNIVERSITY

INTERNATIONAL SUMMER SCHOOL ON COMPUTER SCIENCE, COMPUTER ENGINEERING AND EDUCATION TECHNOLOGY 2018

Proceedings of the ISCSET-2018 workshop
(Novosibirsk, Russia, 12-18 of August)

NOVOSIBIRSK

2018

УДК 004 (063)
ББК 32.97я431
I 69

Edited by *Evgeniy Vanifatiev*

Participating Universities of the ISCSET-2018:

Novosibirsk State Technical University
Chemnitz University of Technology
Harbin University of Science and Technology
Mongolian University of Science and Technology
Darmstadt University of Technology

I69 **International Summer School on Computer Science, Computer Engineering and Education Technology 2018**: Proceedings of the ISCSET-2018 workshop (Novosibirsk, Russia, 12-18 of August) / Edited by E.V Vanifatiev. – Novosibirsk: NSTU Publisher, 2018. –171 p.
ISBN 978-5-7782-3643-1

The book presents scientific research of participants of International Summer School on Computer Science, Computer Engineering and Education Technology 2018 (ISCSET-2018) held in Novosibirsk (Russia) from 12th to 18th of August 2018. The main goal of the annual Summer School is to support researchers to present their ideas to the international community. Key topics of the Summer School are Automatization and machine learning, Embedded systems, Robotics, Computer engineering, Information security, Information technologies for people with higher needs, E-Learning and Digital learning, Evaluation of learning and teaching quality with new methodologies, New teaching methods with ICT for engineering sciences.

УДК 004 (063)
ББК 32.97я431

ISBN 978-5-7782-3643-1

CONTENTS

BlackPearl: Extended Automotive Multi-ECU Demonstrator Platform

Mirko Lippmann, Batbayar Battseren, Ariane Heller, Wolfram Hardt 5

Experiences of using ICT for Teaching Courses of “Mechanics of Materials”

Danaa Ganbat, Radnaa Naidandorj 12

A SIFT-based Image Retrieval system

Haibin Wu, Beiyi Wang, Dewei Guan, Liwei Liu 20

Decoding of digital holograms

Vladimir I. Guzhov, Ekaterina E. Serebryakova 31

Video-based fall detection system in FPGA

Peng Wang, Fanning Kong, Hui Wang 36

Security of Users in Cyberspace

Ivan L. Reva 46

Feature-based Image Processing Algorithms for Vehicle Speed Estimation

Reda Harradi , Ariane Heller, Wolfram Hardt 51

Face Recognition via Joint Feature Extraction based on Multi-task Learning

Ao Li, Deyun Chen, Guanglu Sun, Kezheng Lin 63

Automated setting Eye Diagram for optimization of optical transceiver manufacturing process

Mikhail E. Pazhetnov 71

Experience Implementing Project Training in A Technical University

Alexander.A. Yakimenko 77

Challenges of learning analytics and the current situation

Battsetseg Ts, Munkhchimeg B, Bolor Lkh 84

V. CONCLUSIONS

Based on the analysis of algorithm, a CBIR system based on the SIFT algorithm was designed, and then an experiment proved the availability of the system. Because the system has good robustness to scale changes, translation, rotation and brightness changes, it has broad application prospects in the field of accurate image retrieval, such as pattern recognition, face recognition, video key frame search and medical image retrieval.

ACKNOWLEDGEMENT

This work was financially supported by National Natural Science Foundation of China (Grant No. 61671190).

REFERENCES

[1] Chang T, Kuo C J. Texture analysis and classification with tree-structured wavelet transform[J]. IEEE Transactions on Image Processing A Publication of the IEEE Signal Processing Society, 1993, 2(4):429-441.

[2] Pentland A P, Picard R W, Scarloff S. Photobook: tools for content-based manipulation of image databases[J]. Proceedings of SPIE - The International Society for Optical Engineering, 1994, 2185:34-47.

[3] Jing F, Zhang B, Lin F, et al. A novel region-based image retrieval method using relevance feedback[C]// 2001:28-31.

[4] Pass G, Zabih R. Histogram refinement for content-based image retrieval[C]// IEEE Workshop on Applications of Computer Vision. IEEE Computer Society, 1996:96. .

[5] Smith S M, Brady J M. SUSAN—A New Approach to Low Level Image Processing[J]. International Journal of Computer Vision, 1997, 23(1):45-78. .

[6] Harris C. A combined corner and edge detector[J]. Proc Alvey Vision Conf, 1988, 1988(3):147-151.

[7] Lowe D G, Lowe D G. Distinctive Image Features[J]. 2004.

[8] Zhu Y, Li J, Yang W, et al. A feature points description and matching algorithm for edge in IR/visual images[J]. Jisuanji Fuzhu Sheji Yu Tuxingxue Xuebao/Journal of Computer-Aided Design and Computer Graphics, 2013, 25(6):857-864.

[9] Ma J. A scene matching approach based on edge signal between IR and visible image[D]. The Huazhong University of Science and Technology, Wuhan, China, 2006.

[10] Wang S. SIFT based image matching algorithm research[D]. Xidian University, Xian, China, 2013.

Decoding of digital holograms

Vladimir I. Guzhov[1], Ekaterina E. Serebryakova[2]

[1,2]Novosibirsk State Technical University (NSTU)

vigguzhov@gmail.com[1], silver-kate94@mail.ru[2]

***Abstract* - The article describes a system for recording digital holograms. The Fresnel transformation is used for decoding.**

***Keywords* - holography, optical microscopy, interference, digital holography, Fresnel transform, Fourier transform.**

I. INTRODUCTION

To register classical thin holograms it is necessary to use high-resolution photographic media. This is due to the fact that when the real and imaginary images are restored they overlap with the central beam. E. Leith and Yu. Upatnieks solved the problem of separation of beam overlap as follows [1]: they directed an object beam of light onto a photographic plate at a rather large angle with a beam of light diffracted by the object; this made it possible to obtain images that, when observed, do not overlap. To record a hologram at an angle between interfering strips of 30 degrees, a recording material with a resolution of at least 2000 lines / mm is required for recording only the carrier frequency.

Digital matrices used in digital holography can't at the moment provide such a high spatial resolution. Therefore, in digital holographic reconstruction, it is necessary to reduce the angle between the interfering wave fields, which inevitably leads to overlapping of the spectra in different diffraction orders.

II. THEORY

The existing methods for decoding holograms are based on the fact that we can register only the intensity of the hologram. However, in contrast to recording classical holograms that represent a picture of intensities, using digital holography one can obtain a complex mathematical hologram [2], which consists of the amplitude and phase of the object field:

$$G(x,y) = a_p(x,y)\exp\left(\varphi_p(x,y)\right) \quad (1)$$

$a_p(x,y)$ - field amplitude, $\varphi_p(x,y)$ phase of the field propagated from the object in the plane of the hologram (η,ξ).

The amplitude and phase values can be found from the set of holograms using phase-shifting interferomet

The stepwise phase shift method is based on recording several interference patterns when the reference wave phase changes by a certain amount. The phase shift between interfering beams can be realized in various ways. The phase shift is most often set using a mirror fixed to a piezoceramic. Depending on the number of phase shifts, there are various decoding algorithms.ry (PSI) methods.

In [3] it is shown how to obtain computational procedures which, using combinations of intensity of interference patterns, obtain the distribution of the phase difference $\phi(x,y)$ of interfering beams for arbitrary angles of displacement. In [4-6], a generalized scheme of the algorithm for a different number of shifts is obtained. Knowing the phase difference $\phi(x,y)$ and the phase of the reference wave $\varphi_r(x,y)$, it is possible to determine the initial phase distribution $\varphi_p(x,y)$.

$$\varphi_p(x,y)=\phi(x,y)-\varphi_r(x,y) \tag{2}$$

To form a mathematical hologram it is also necessary to determine the amplitude of the wave field $a_p(x,y)$ reflected from the object in the plane of the hologram. The values of the amplitudes of the object and reference beam can be determined by overlapping the corresponding beams in the optical circuit. But if we already have a set of registered holograms with a phase shift used to determine the phase values, then we can obtain the amplitude of the object beam by the stepwise shift method using the same set of holograms [7,8].

If you can find a mathematical hologram $G(x,y)$, then in the image plane you can restore the complex amplitude of the field scattered from the object. For this, it is necessary to carry out the Fresnel transformation over $G(x,y)$ [9].

$$\Gamma(r,s)=\frac{1}{i\lambda d}exp\left[i\frac{2\pi d}{\lambda}\right]\exp\left[i\frac{\pi\left[(r\Delta\xi)^2+(s\Delta\eta)^2\right]}{\lambda d}\right]\times \tag{3}$$

$$\times\sum_{k}^{N_x-1}\sum_{l}^{N_y-1}b_1(k,l)\exp\left[i\frac{\pi}{\lambda d}\left[(k\Delta\xi)^2+(l\Delta\eta)^2\right]\right]\exp\left[-i\frac{2\pi}{N}(kr+ls)\right]$$

In expression (3), d - the distance to the object. The Fresnel transformation algorithm provides a simple scaling of the reconstructed image, but this imposes a number of limitations on the design of the measuring system, in particular, the upper and lower limits of the permissible recording distance of the hologram become a significant factor.

It is necessary to determine at what distances we can use the discrete Fresnel transform. It was shown in [10] that discrete Fresnel and Fourier transforms can be used when the distance to the object is comparable with the size of the object and hologram, while the object is in the near zone of diffraction. When recording digital holograms, the optical scheme shown in Fig. 1.

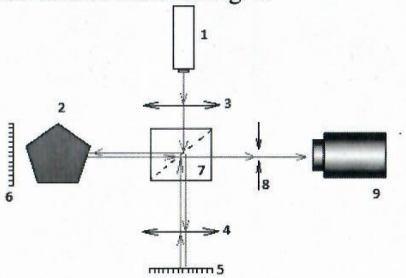

Fig. 1. Scheme of recording a digital hologram

The beam of light from the laser expands (3) and hits the separation cube. Part of the beam hits the mirror fixed to the piezoceramic (5). When reflecting from this mirror, an object beam is formed. Another part of the beam hits the object. When reflecting from the object (2), a reference beam is formed. To equalize the intensities of the reference and object beams, a light filter is used to form the hologram (4). The interference of the reference and object beams and the formation of holograms occurs on the camera array (9).

III. EXPERIMENTS AND RESULTS

The object was a jubilee silver badge with the emblem of the university. In Fig. 2 shows the results of interference between the reference and object beams when the phase angle of the shift is changed . Interference patterns were projected directly onto the digital array of photodetectors.

Figure 2. Interference patterns with a change in the phase angle of shear $\delta_1=0^\circ$, $\delta_2=90^\circ$, $\delta_3=180^\circ$, $\delta_3=270^\circ$

For these pictures, the phase distribution and amplitude were determined. Then a mathematical hologram was formed using the expression (1). In Fig. 3 shows the amplitude and phase of the mathematical hologram.

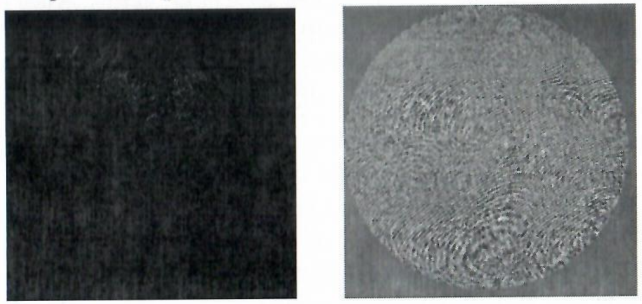

Figure 3. Amplitude and phase of the mathematical hologram.

The actual image was reconstructed from the mathematical hologram using the Fresnel transform. The size of the object is 7 mm, the distance to the object is 135 mm. The result of the restoration is shown in Fig. 4.

Figure 4. Left source object, right: the result of restoring the actual image from the mathematical hologram.

The noise in Fig. 4 are caused by the deflection of the reference beam from the plane beam. By improving the quality of optical elements, this factor can be eliminated.

This work was supported by the Russian Foundation for Basic Research "Development and research of computer holographic interferometry methods for complex objects" (Grant No. 18-08-00580).

REFERENCES

[1] Leith, E.N. Reconstructed wavefronts and communication theory [Text] E.N. Leith, J. Upatnieks. Journal of the Optical Society of America, 1962, Vol. 52, pp. 1123-1130.

[2] YAroslavskij, L.P. Cifrovaya golografiya [Tekst]. L.P. YAroslavskij, N.S. Merzlyakov. – M.: Nauka, 1982, P. 219 .

[3] Guzhov V.I., Il'inyh S.P. Opticheskie izmereniya. Komp'yuternaya interferometriya: Ucheb. posobie. - Moskva: Izd-vo YUrajt, 2018. (ISBN: 978-5-534-06855-9), P.258.

[4] Guzhov V., Ilinykh S., Kuznetsov R., Haydukov D. Generic algorithm of phase reconstruction in phase-shifting interferometry. Optical Engineering, 2013, Vol.52(3), pp. 030501-1 – 030501-2.

[5] Guzhov V.I., Il'inyh S.P., Hajdukov D.S., Vagizov A.R. Universal'nyj algoritm rasshifrovki. Nauchnyj vestnik NGTU, 2010, №4(41), pp. 51-58.

[6] Il'inyh S.P., Guzhov V.I. Obobshchennyj algoritm rasshifrovki interferogramm s poshagovym sdvigom. Avtometriya, 2002, №3, pp.123-126.

[7] Guzhov V.I., Il'inyh S.P., Hajbulin S.V. Vosstanovlenie fazovoj informacii na osnove metodov poshagovogo fazovogo sdviga pri malyh uglah mezhdu interferiruyushchimi puchkami. Avtometriya, 2017, T. 53, №3, pp. 101-106.

[8] Guzhov V.I., Il'inyh S.P. Opredelenie intensivnosti opornogo i ob"ektnogo puchkov pri ispol'zovanii metoda poshagovogo fazovogo sdviga. NGTU, Novosibirsk, Rossiya. Avtomatika i programmnaya inzheneriya, 2017, № 4 (22), pp. 68–73.

[9] Predstavlenie preobrazovaniya Frenelya v diskretnom vide. Guzhov V.I., Nesin R.B., Emel'yanov V.A. Avtomatika i programmnaya inzheneriya, Novosibirsk, 2016, №1(15), pp. 91–96

[10] Oblast' vozmozhnogo primeneniya diskretnyh preobrazovanij Fur'e i Frenelya. Guzhov V.I., Emel'yanov V.A., Hajdukov D.S. Avtomatika i programmnaya inzheneriya, Novosibirsk , 2016. №1(15), pp. 97–103