PROCEEDINGS OF SPIE

Applications of Digital Image Processing XLIII

Andrew G. Tescher Touradj Ebrahimi Editors

24 August – 4 September 2020 Online Only, United States

Sponsored and Published by SPIE

Volume 11510

Part One of Two Parts

Proceedings of SPIE 0277-786X, V. 11510

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

Applications of Digital Image Processing XLIII, edited by Andrew G. Tescher, Touradj Ebrahimi, Proc. of SPIE Vol. 11510, 1151001 · © 2020 SPIE CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2581642

Proc. of SPIE Vol. 11510 1151001-1

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIEDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in Applications of Digital Image Processing XLIII, edited by Andrew G. Tescher, Touradj Ebrahimi, Proceedings of SPIE Vol. 11510 (SPIE, Bellingham, WA, 2020) Seven-digit Article CID Number.

ISSN: 0277-786X ISSN: 1996-756X (electronic)

ISBN: 9781510638266 ISBN: 9781510638273 (electronic)

Published by **SPIE** P.O. Box 10, Bellingham, Washington 98227-0010 USA Telephone +1 360 676 3290 (Pacific Time) · Fax +1 360 647 1445 SPIE.org Copyright © 2020, Society of Photo-Optical Instrumentation Engineers.

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$21.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/20/\$21.00.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.



Paper Numbering: Proceedings of SPIE follow an e-First publication model. A unique citation identifier (CID) number is assigned to each article at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

• The first five digits correspond to the SPIE volume number.

• The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

11510 2H	Fast VVC intra prediction mode decision based on block shapes [11510-85]
11510 2K	Spectropolarimetry diagnostics of cervical cytological smears for availability of papillomavirus [11510-88]
11510 2L	Differential diagnosis of adenocarcinoma and squamous cell carcinoma of the cervix by spectropolarimetry [11510-89]
11510 2M	Vector-parametric structure of polarization images of networks of biological crystals for differential diagnosis of inflammatory processes [11510-90]
11510 2N	IR spectrum comparison of the blood of breast cancer patients as a preliminary stage of further molecular genetic screening [11510-91]
11510 20	Multiparametric polarization histology in the detection of traumatic changes in the optical anisotropy of biological tissues [11510-92]
11510 2P	Digital processing of fluorimetry imaging of deep layers in the macula of the retina in diabetic macular edema [11510-93]
11510 2Q	Diffuse tomography of brain nerve tissue in the temporary monitoring of pathological changes in optical anisotropy [11510-94]
11510 2R	Multichannel polarization sensing of polycrystalline blood films in the diagnosis of the causes of poisoning [11510-95]
11510 28	Azimuthally invariant Mueller-matrix tomography of the distribution of phase and amplitude anisotropy of biological tissues [11510-96]
11510 2T	Polarization-phase diagnostics of volume of blood loss [11510-97]
11510 20	LFDD: Light field image dataset for performance evaluation of objective quality metrics [11510-98]
11510 2V	Noise phase singularities in noise contaminated images [11510-99]
11510 2W	Automatic motion tracking system for analysis of insect behavior [11510-100]
11510 2X	Image dehazing based on microscanning approach [11510-101]
11510 2Y	An efficient algorithm of total variation regularization in the two-dimensional case [11510-102]
11510 2Z	Neural network and non-rigid ICP in facial recognition problem [11510-103]
11510 32	Near-infrared image enhancement through multi-scale alpha-rooting processing for remote sensing application [11510-106]
11510 33	3D image augmentation using neural style transfer and generative adversarial networks [11510-107]

PROCEEDINGS OF SPIE

SPIEDigitalLibrary.org/conference-proceedings-of-spie

Diffuse tomography of brain nerve tissue in the temporary monitoring of pathological changes in optical anisotropy

Garazdyuk, M., Vanchulyak, O., Zavolovich, Y., Tomka, Y., Soltys, I., et al.

M. Garazdyuk, O. Vanchulyak, Y. Zavolovich, Y. Tomka, I. Soltys, O. Dubolazov, V. Dvorjak, "Diffuse tomography of brain nerve tissue in the temporary monitoring of pathological changes in optical anisotropy," Proc. SPIE 11510, Applications of Digital Image Processing XLIII, 115102Q (21 August 2020); doi: 10.1117/12.2568443



Event: SPIE Optical Engineering + Applications, 2020, Online Only

Diffuse tomography of brain nerve tissue in the temporary monitoring of pathological changes in optical anisotropy

M.Garazdyuk¹, O.Vanchulyak¹, Y. Zavolovich¹, Yu. Tomka², I. Soltys², O. Dubolazov², V. Dvorjak²

¹ Bukovinian State Medical University, 3 Theatral Sq., Chernivtsi, Ukraine, 58000 ² Chernivtsi National University, 2 Kotsiubynskyi Str., Chernivtsi, Ukraine, 58012

a.dubolazov@chnu.edu.ua

ABSTRACT

- 1. Development of a structural-logical scheme and experimental testing of methods and means of diffuse tomography new in forensic practice for reproducing fluctuations in the magnitude of linear and circular birefringence and dichroism of the polycrystalline structure of histological sections of the brain.
- 2. Experimental determination of a set of maps and histograms fluctuation distributions of linear (FFLB) and circular (FFCB) birefringence and dichroism (FALD and FACD) for differential diagnosis of traumatic hemorrhage, cerebral infarction ischemic and hemorrhagic genesis using diffuse tomography of polycrystalline structure of histological sections of the brain.
- 3. Information analysis to determine the operational characteristics of the force (sensitivity, specificity and balanced accuracy) of the diffuse tomography method.

Keywords: diffuse tomography, anisotropy, brain nerve tissue, diagnostics.

1. DIFFERENTIAL DIAGNOSIS OF THE FORMATION OF HEMORRHAGES OF TRAUMATIC GENESIS, CEREBRAL INFARCTION OF ISCHEMIC AND HEMORRHAGIC GENESIS USING MUELLER-MATRIX MICROSCOPY

1.1. Azimuthally invariant Mueller-matrix images of the optical activity of histological sections of the brain.

The results of the study of the coordinate distributions of the Mueller-matrix invariant of circular birefringence (MMI OA) of protein complexes of the nervous tissue of samples of histological sections of the brain of dead from various groups are presented in a series of fragments of fig.1¹⁻⁴.

Applications of Digital Image Processing XLIII, edited by Andrew G. Tescher, Touradj Ebrahimi, Proc. of SPIE Vol. 11510, 115102Q · © 2020 SPIE CCC code: 0277-786X/20/\$21 · doi: 10.1117/12.2568443

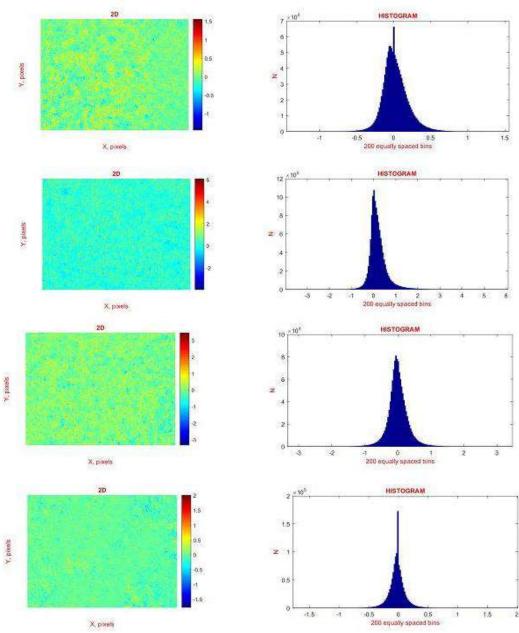


Fig. 1. Maps ((1), (2), (3), (4)) and histograms ((4), (5), (6), (7)) the distribution of the MMI OA of histological sections of the brain of the dead from group 1 ((1), (5)), group 2 ((2), (6)), group 3 ((3), (7)) and group 4 ((4), (8)).

From the analysis of the data obtained by Mueller-matrix mapping of polarization manifestations of optical activity⁵⁻⁹:

- more homogeneous, in comparison with the results of the polarimetry of the distributions of the OP values and PP, the coordinate-inhomogeneous structure of all MMI OA maps of histological sections of the brain of nervous tissue of deceased from all groups (fig. 1, fragments (1), (3), (5), (7));
- for histograms characterizing the MMI maps of samples from all (control 1 and research 2 4) groups, a small scatter of values (dispersion), significant asymmetry (), and sharpness (excess) of the peak (Fig. 1, fragments (2), (4), (6), (8));

• the difference in the statistical structure of the coordinate distributions of the magnitude of the MMI OA of histological sections of the brain of the dead from control group 1 and all research groups 2 - 4 - (Fig. 1, fragment (1) and fragments (4),(6),(8)).

Table 1 presents the average values and errors $(\pm \Omega)$ determination of the set of statistical moments of the 1st - 4th orders $SM_{i=1-4}$ that characterize the Mueller-matrix images of the polarization of the manifestations of the circular birefringence of optically active protein complexes of the nervous tissue of the brain.

A comparative analysis with the data of statistical analysis of laser microscopic polarimetry of the distributions of the OP and PP values of digital microscopic images of histological sections of the brain revealed the diagnostic sensitivity of statistical moments of the 3rd and 4th orders (highlighted in green - table 1) for azimuthally invariant Mueller-matrix differentiation of brain nerve tissue samples of the dead from control group 1 and all research groups 2 - 4 (p_1 p 0,05).

Intergroup (research groups 2–4) differences between the coordinate divisions of the MMI OA of the research representative samples of histological sections of the brain were also statistically unreliable - $p_{i=2:3:4}$ f 0,05.

Parameters	Group 1	Group 2	Group 3	Group 4	
SM_1	$0,21 \pm 0,009$	$0,\!19\pm0,\!008$	$0,17 \pm 0,007$	$0,\!18\pm0,\!008$	
p_1		p	p	<i>p</i> \ 0,05	
p_2		$p \phi$	0,05	<i>p</i> \ 0,05	
<i>p</i> ₃		p	$p \neq 0.05$ $p \neq 0.05$		
p_4			p		
SM_2	$0,\!17\pm0,\!007$	$0,\!21\pm0,\!009$	$0,18 \pm 0,008$	$0,14 \pm 0,006$	
p_1		p	p	p	
<i>p</i> ₂		p \ 0,05		<i>p</i> \oplus 0,05	
p_3		$p \neq 0.05$ $p \neq 0.05$		0,05	
p_4			p		
SM ₃	$0,59 \pm 0,026$	$0,71 \pm 0,031$	$0,81 \pm 0,037$	$0,88 \pm 0,039$	
p_1		<i>p</i> p 0,05	<i>p</i> p 0,05	<i>p</i> p 0,05	
p_2		p \u03c6 0,05		<i>p</i> f 0,05	
<i>p</i> ₃		p	<i>p</i> f	0,05	
p_4		<i>p</i> f 0,05			
SM_4	2,51±0,11	3,11±0,14	3,36±0,15	4,01±0,18	
p_1		<i>p</i> p 0,05	<i>p</i> p 0,05	<i>p</i> p 0,05	
<i>p</i> ₂		<i>p</i> \$	0,05	<i>p</i> \ 0,05	
<i>p</i> ₃		<i>p</i> f 0,05	<i>p</i> f	0,05	
p_4			<i>p</i> f 0,05		

Table 1. Statistical moments of the 1st - 4th orders characterizing the distribution of the magnitude of the MMI OA of histological sections of the brain of groups 1 - 4

1.2. Operational characteristics of the method of statistical analysis of maps of MMI OA of histological sections of the brain.

A certain increase in the diagnostic efficiency and strength of the method of microscopic azimuthally invariant Muellermatrix polarimetry of the distributions of the values of MMI OA for objective statistical differentiation of the causes of death is illustrated by the values of the set of operational characteristics (sensitivity, specificity and balanced accuracy), which are shown in table 2.

Groups "1 – 2+3+4"				
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%	
SM_1	a = 63; b = 37	c = 61; d = 39	<i>n</i> = 100	
	63	61	62	
SM_2	a = 61; b = 39	c = 60; d = 40	<i>n</i> = 100	
	61	60	60,5	
SM_3	a = 77; b = 23	c = 75; d = 25	<i>n</i> = 100	
	77	75	76	
SM_4	a = 73; b = 27	c = 71; d = 29	<i>n</i> = 100	
	73	71	72	
		ups "2 – 3"		
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%	
SM_1	a = 62; b = 38	c = 61; d = 39	<i>n</i> = 100	
	62	61	61,5	
SM_2	a = 61; b = 39	c = 61; d = 39	<i>n</i> = 100	
	61	61	61	
SM_3	a = 65; b = 35	c = 63; d = 37	<i>n</i> = 100	
	65	63	64	
SM_4	a = 63; b = 37	c = 61; d = 39	<i>n</i> = 100	
	63	61	62	
		ups "2 – 4"	ſ	
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%	
SM_1	a = 63; b = 37	c = 61; d = 39	<i>n</i> = 100	
	63	61	62	
SM_2	a = 62; b = 38	c = 61; d = 39	<i>n</i> = 100	
	62	61	61,5	
SM_3				
5111 3	a = 66; b = 34	c = 64; d = 36	<i>n</i> = 100	
5111 3	a = 66; b = 34 66	c = 64; d = 36 64	<i>n</i> = 100 65	
SM 3				
5	66 <i>a</i> = 65; <i>b</i> = 35 65	64 c = 64; d = 36 64	65	
SM ₄	66 a = 65; b = 35 65 Gro	64 $c = 64; d = 36$ 64 ups "3 - 4"	65 n = 100 64,5	
SM ₄ Parameters	66 a = 65; b = 35 65 Gro Sensitivity, Se,%		65 <i>n</i> = 100 64,5 Accuracy, <i>Ac</i> ,%	
SM ₄	66 a = 65; b = 35 65 Gro	64 $c = 64; d = 36$ 64 ups "3 - 4"	65 <i>n</i> = 100 64,5 Accuracy, <i>Ac</i> ,% <i>n</i> = 100	
SM ₄ Parameters	66 a = 65; b = 35 65 Gro Sensitivity, Se,%		65 n = 100 64,5 Accuracy, Ac,% n = 100 61,5	
SM ₄ Parameters	66 <i>a</i> = 65; <i>b</i> = 35 65 Gro Sensitivity, <i>Se</i> ,% <i>a</i> = 62; <i>b</i> = 38	64 $c = 64; d = 36$ 64 ups "3 - 4" Specificity, Sp,% $c = 61; d = 39$	65 <i>n</i> = 100 64,5 Accuracy, <i>Ac</i> ,% <i>n</i> = 100	
$\frac{SM_4}{Parameters}$	66 $a = 65; b = 35$ 65 Gro Sensitivity, Se,% $a = 62; b = 38$ 62	64 $c = 64; d = 36$ 64 ups "3 - 4" Specificity, Sp,% $c = 61; d = 39$ 61	65 <i>n</i> = 100 64,5 Accuracy, <i>Ac</i> ,% <i>n</i> = 100 61,5 <i>n</i> = 100 61	
$\frac{SM_4}{Parameters}$	66 $a = 65; b = 35$ 65 Gro Sensitivity, Se,% $a = 62; b = 38$ 62 $a = 61; b = 39$	64 $c = 64; d = 36$ 64 ups "3 - 4" Specificity, Sp,% $c = 61; d = 39$ 61 $c = 61; d = 39$	65 <i>n</i> = 100 64,5 Accuracy, <i>Ac</i> ,% <i>n</i> = 100 61,5 <i>n</i> = 100	

 Table 2. The specificity, sensitivity, accuracy of the method of statistical analysis of maps of MMI OA of histological sections of the brain

SM_4	a = 63; b = 37	c = 60; d = 40	<i>n</i> = 100
	63	60	61,5

For each of the 1st-4th-order statistical moments that characterize the MMI OA maps of circularly birefringent protein complexes of histological sections of the brain of deceased from all groups, the sensitivity Se,%, specificity Sp,% and balanced accuracy Ac,% increase by 10% -15% compared with direct data polarization mapping¹⁰⁻¹⁵.

For a third-order statistical moment, which characterizes the asymmetry of the distributions of the MMI OA, the strength of the Mueller-matrix microscopy method in the differentiation of samples from the control and experimental groups reaches a satisfactory level -75% - 77%.

1.3. Azimuthally invariant Mueller-matrix images of linear birefringence of histological sections of the brain.

In fig. 2 shows the results of the azimuthally invariant Mueller matrix mapping of maps (fragments (1), (3), (5), (7)) and histograms of the distribution of magnitude (fragments (2), (4), (6), (8)) MMI LB, characterizing the polarization manifestations of linear birefringence of the fibrillar networks of the brain nervous tissue of the dead from groups 1-4.

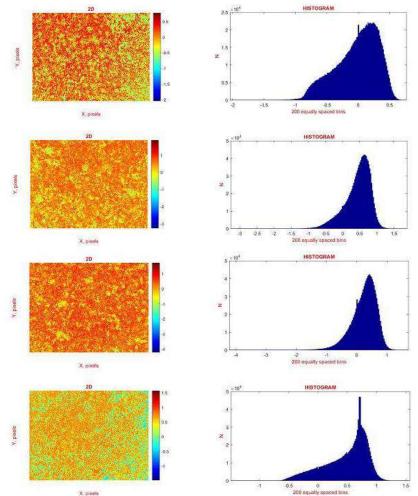


Fig. 2. Maps ((1), (2), (3), (4)) and histograms ((4), (5), (6), (7)) the distribution of the MMI of the LD of histological sections of the brain of the dead from group 1 ((1), (5)), group 2 ((2), (6)), group 3 ((3), (7)) and group 4 ((4), (8)).

A comparative analysis of the results of Mueller-matrix mapping of polarization manifestations of linear birefringence of fibrillar networks of brain samples was found:

- significant, in comparison with the results of polarimetric distributions of the values of OP and PP and MMI OA (fig. 1), coordinate-heterogeneous heterogeneity of the MMI LB maps of histological sections of the brain tissue of the dead of all groups (fig. 2, fragments (1), (3), (5), (7));
- histograms characterizing the distribution of the MMI LB value of samples from all (control 1 and research 2 4) groups are characterized by individual and significant scatter of values (dispersion SM₂), asymmetry (SM₃) and peak acuity (excess SM₄) (Fig. 2, fragments (2), (4), (6), (8))
- the difference in the statistical structure of the coordinate distributions of the magnitude of the MMI LB of histological sections of the nervous tissue of the brain of the dead not only from the control group 1 and all research groups 2 4 (fig. 2, fragment (1) and fragments (4), (6), (8)), but also within the intergroup limits "group 2 group 4" and "group 2 and group 3"

Table 3 shows the data of statistical analysis of the maps of MMI LB of the brain nervous tissue.

Table 3. Statistical moments of the 1st - 4th orders characterizing the distribution of the value of MMI LB histological sections of the brain of groups 1 - 4

Parameters	Group 1	Group 2	Group 3	Group 4
SM_1	$0,21 \pm 0,009$	$0,24 \pm 0,011$	$0,23 \pm 0,01$	$0,19 \pm 0,008$
p_1		<i>p</i> π 0,05	<i>p</i> π 0,05	<i>p</i> π 0,05
<i>p</i> ₂		$p \neq 0.05$ $p \neq 0.05$		
<i>p</i> ₃		$p \neq 0.05$ $p \neq 0.05$		
p_4			p	
SM ₂	$0,24 \pm 0,011$	0,37±0,017	$0,35 \pm 0,016$	$0,31 \pm 0,014$
p_1		<i>p</i> π 0,05	<i>p</i> π 0,05	<i>p</i> π 0,05
<i>p</i> ₂		р ф	0,05	p
<i>p</i> ₃		$p \neq 0.05$ $p \neq 0.05$		
p_4		<i>p</i> \ 0,05		
SM ₃	$0,61 \pm 0,027$	$0,75 \pm 0,034$	$0,78 \pm 0,035$	$0,91 \pm 0,044$
p_1		<i>p</i> π 0,05	<i>p</i> π 0,05	<i>p</i> π 0,05
p_2		<i>p</i> \ 0,05 <i>p</i>		<i>p</i> π 0,05
<i>p</i> ₃		p	р ф	0,05
p_4		p \ 0,05		
SM_4	$0,87 \pm 0,041$	$1,02 \pm 0,048$	$1,12 \pm 0,051$	$1,32 \pm 0,059$
<i>p</i> ₁		<i>p</i> π 0,05	<i>p</i> π 0,05	<i>p</i> π 0,05
<i>p</i> ₂		$p \phi 0,05$ $p \phi 0,05$		p
<i>p</i> ₃		p	р ф	0,05
p_4		p \u03c6 0,05		

A comparative analysis with the data of statistical analysis of laser microscopic polarimetry of the distributions of the OP and PP values of digital microscopic images and MMI OA of histological sections of the brain, presented in table 1, showed the diagnostic sensitivity of statistical moments of the 2nd - 4th orders (highlighted in green - table 3) for microscopic azimuthally invariant Mueller-matrix differentiation of the manifestations of linear birefringence of fibrillar networks of brain nerve tissue samples of the dead from the control group 1 and all the groups 2 - 4 ($p_1 p 0,05$). In addition, the possibility of intergroup (research groups 2–4) statistical differentiation of the coordinate distributions of the magnitude of the MMI LB of representative samples of histological sections of the brain – group 2 – group 4 "($p_3 p 0,05$) and" group 2 and group 3 "($p_2 p 0,05$) was revealed.

1. 4. Operational characteristics of the method of statistical analysis of maps MMI LB histological sections of the brain.

A significant increase in the operational characteristics characterizing the strength of the method of microscopic azimuthally invariant Mueller-matrix polarimetry of the distributions of the MMI LB of brain nerve tissue samples for objective statistical differentiation of the causes of death illustrate the sensitivity, specificity and balanced accuracy values shown in table 4.

For each set of statistical moments 1–4 orders of magnitude, which characterize the coordinate distributions of the magnitude of the MMI LB of the fibrillar networks of the nervous tissue of samples of histological sections of the brain of deceased from all groups, the sensitivity Se,%, specificity Sp,% and balanced accuracy increase Ac,% by 12% – 18% in compared with the data of Mueller-matrix mapping of polarization manifestations of the optical activity of protein complexes (table 2).

For statistical moments of the 1st, 3rd and 4th orders characterizing the distribution of the MMI LB, the strength of the Mueller-matrix microscopy method in the differentiation of samples from the control and experimental groups reaches a satisfactory level -75% - 85%.

Groups "1 – 2+3+4"						
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%			
SM_1	a = 77; b = 23	c = 75; d = 25	<i>n</i> = 100			
-	77	75	76			
SM_2	a = 72; b = 28	c = 69; d = 31	<i>n</i> = 100			
	72	69	71			
SM_3	a = 82; b = 18	c = 79; d = 21	<i>n</i> = 100			
	82	79	81			
SM_4	a = 85; b = 15	c = 81; d = 19	<i>n</i> = 100			
	85	81	83			
	Gro	oups "2 – 3"	1			
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%			
SM_1	a = 66; b = 34	c = 64; d = 36	<i>n</i> = 100			
	66	64	65			
SM_2	a = 68; b = 32	c = 65; d = 35	<i>n</i> = 100			
	68	65	66,5			
SM_3	a = 80; b = 20	c = 76; d = 24	<i>n</i> = 100			
	80	76	78			
SM_4	a = 81; b = 19	c = 77; d = 23	<i>n</i> = 100			
	81	77	79,5			
	Groups "2 – 4"					
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%			
SM_1	a = 63; b = 37	c = 60; d = 40	<i>n</i> = 100			
	63	60	61,5			
SM_2	a = 65; b = 35	c = 62; d = 38	<i>n</i> = 100			
	65	62	63,5			
SM_3	a = 78; b = 22	c = 75; d = 25	<i>n</i> = 100			

Table 4. The specificity, sensitivity, accuracy of the method of statistical analysis of maps MMI LB of histological sections of the brain

Proc. of SPIE Vol. 11510 115102Q-7

Downloaded From: https://www.spiedigitallibrary.org/conference-proceedings-of-spie on 16 Oct 2020 Terms of Use: https://www.spiedigitallibrary.org/terms-of-use

	78	75	76,5
SM_4	a = 79; b = 21	c = 77; d = 23	<i>n</i> = 100
	79	77	78
	Gra	oups "3 – 4"	
Parameters	Sensitivity, Se,%	Specificity, Sp,%	Accuracy, Ac,%
SM_1	a = 61; b = 39	c = 60; d = 40	<i>n</i> = 100
	61	60	60,5
SM_2	a = 63; b = 37	c = 61; d = 39	<i>n</i> = 100
	63	61	62
SM ₃	a = 66; b = 34	c = 63; d = 37	<i>n</i> = 100
	66	63	64,5
SM_4	a = 70; b = 30	c = 66; d = 34	<i>n</i> = 100
	70	66	68

CONCLUSIONS

The effectiveness between the group differentiation of samples of deaths from traumatic hemorrhage (group 2) and ischemic cerebral infarction (group 3) reaches a satisfactory level and is 77% - 81%.

A similar (satisfactory - 75% - 79%) level of differentiation corresponds to the diagnostic capabilities of MMI LB microscopy of samples of patients who died from hemorrhagic (group 4) and ischemic cerebral infarction (group 3).

For control group 1 (coronary heart disease) and research group 3 (ischemic cerebral infarction), the method of azimuthally invariant Mueller-matrix mapping of polarization manifestations of linear birefringence of the fibrillar networks of the nerve tissue of the brain of the dead was uneffective - the strength of the method lies within an unsatisfactory level -60% - 70%.

REFERENCES

- [1]. G. Müller *et al.*, Eds., "Medical Optical Tomography: Functional Imaging and Monitoring," SPIE Press, Vol. IS11, Bellingham, Washington 1993.
- L. V. Wang and H.-I. Wu. "Biomedical Optics: Principles and Imaging," Wiley-Interscience, Hoboken, New Jersey 2007.
- [3]. D. Boas, C. Pitris and N. Ramanujam Eds. "Handbook of Biomedical Optics," CRC Press, Boca Raton, London, New York 2011.
- [4]. T. Vo-Dinh, Ed., "Biomedical Photonics Handbook," 2nd ed., CRC Press, Boca Raton 2014.
- [5]. V. V. Tuchin, "Tissue Optics: Light Scattering Methods and Instruments for Medical Diagnostics," 3rd ed., Vol. PM 254, SPIE Press, Bellingham, Washington 2015.
- [6]. N. Ghosh and I. A. Vitkin. "Tissue polarimetry: concepts, challenges, applications and outlook," J. Biomed. Opt. 2011; 16: 110801.
- [7]. Angelsky, O. V., Bekshaev, A. Y. A., Maksimyak, P. P., Maksimyak, A. P., & Hanson, S. G. (2018). Low-temperature laser-stimulated controllable generation of micro-bubbles in a water suspension of absorptive colloid particles. Optics Express, 26(11), 13995-14009.
- [8]. Angelsky, O. V. (2007). Optical correlation techniques and applications. Optical correlation techniques and applications (pp. 1-270)
- [9]. Angelsky, O. V., Ushenko, A. G., Pishak, V. P., Burkovets, D. N., Yermolenko, S. B., Pishak, O. V., & Ushenko, Y. A. (2000). Coherent introscopy of phase-inhomogeneous surfaces and layers. Paper presented at the Proceedings of SPIE - the International Society for Optical Engineering, 4016 413-418.
- [10]. Angelsky OV, Bekshaev AY, Hanson SG, Zenkova CY, Mokhun II and Jun Z (2020) Structured Light: Ideas and Concepts. Front. Phys. 8:114.

- [11]. Angelsky OV, Zenkova CY, Hanson SG and Zheng J (2020) Extraordinary Manifestation of Evanescent Wave in Biomedical Application. Front. Phys. 8:159.
- [12]. Ushenko, Yu.A., Bachynsky, V.T., Vanchulyak, O.Ya., Dubolazov, A.V., Garazdyuk, M.S., Ushenko, V.A., "Jones-matrix mapping of complex degree of mutual anisotropy of birefringent protein networks during the differentiation of myocardium necrotic changes," (2016) Applied Optics, 55 (12), pp. B113-B119.
- [13]. Ushenko, Yu.A., Dubolazov, A.V., Karachevtcev, A.O., Zabolotna, N.I., "A fractal and statistic analysis of Mueller-matrix images of phase inhomogeneous layers,"(2011) Proceedings of SPIE - The International Society for Optical Engineering, 8134, 81340P.
- [14]. Ushenko, V.A., Dubolazov, A.V., "Correlation and self similarity structure of polycrystalline network biological layers Mueller matrices images," (2013) Proceedings of SPIE - The International Society for Optical Engineering, 8856.
- [15]. "Cassidy, "Basic concepts of statistical analysis for surgical research," Journal of Surgical Research 128,199-206 (2005).