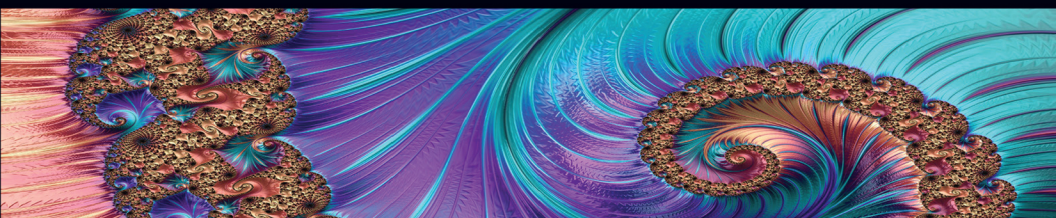


CRC FOCUS



NEAR-INFRARED SPECKLE
CONTRAST DIFFUSE CORRELATION
TOMOGRAPHY FOR NONCONTACT
IMAGING OF TISSUE BLOOD
FLOW DISTRIBUTION

Daniel Irwin, Siavash Mazdeyasna,
Chong Huang, Mehrana Mohtasebi,
Xuhui Lui, Lei Chen, Guoqiang Yu



CRC Press
Taylor & Francis Group

Near-infrared Speckle Contrast Diffuse Correlation Tomography for Noncontact Imaging of Tissue Blood Flow Distribution

Imaging of tissue blood flow (BF) distributions provides vital information for the diagnosis and therapeutic monitoring of various vascular diseases. The innovative near-infrared speckle contrast diffuse correlation tomography (scDCT) technique produces full 3D BF distributions. Many advanced features are provided over competing technologies including high sampling density, fast data acquisition, noninvasiveness, noncontact, affordability, portability, and translatability across varied subject sizes. The basic principle, instrumentation, and data analysis algorithms are presented in detail. The extensive applications are summarized such as imaging of cerebral BF (CBF) in mice, rat, and piglet animals with skull penetration into the deep brain. Clinical human testing results are described by recovery of BF distributions on preterm infants (CBF) through incubator walls, and on sensitive burn tissues and mastectomy skin flaps without direct device–tissue interactions. Supporting activities outlined include integrated capability for acquiring surface curvature information, rapid 2D BF mapping, and optimizations via tissue-like phantoms and computer simulations. These applications and activities both highlight and guide the reader as to the expected abilities and limitations of scDCT for adapting into their own preclinical/clinical research, use in constrained environments (i.e., neonatal intensive care unit bedside), and use on vulnerable subjects and measurement sites.



Taylor & Francis

Taylor & Francis Group

<http://taylorandfrancis.com>

Near-infrared Speckle Contrast Diffuse Correlation Tomography for Noncontact Imaging of Tissue Blood Flow Distribution

Daniel Irwin, Siavash Mazdeyasna,
Chong Huang, Mehrana Mohtasebi, Xuhui Liu,
Lei Chen and Guoqiang Yu



CRC Press

Taylor & Francis Group

Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **informa** business

First edition published 2022

by CRC Press

6000 Broken Sound Parkway NW, Suite 300, Boca Raton, FL 33487-2742

and by CRC Press

4 Park Square, Milton Park, Abingdon, Oxon, OX14 4RN

CRC Press is an imprint of Taylor & Francis Group, LLC

© 2023 Daniel Irwin, Siavash Mazdeyasna, Chong Huang, Mehrana Mohtasebi, Xuhui Liu, Lei Chen, Guoqiang Yu

Reasonable efforts have been made to publish reliable data and information, but the author and publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors and publishers have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, access www.copyright.com or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. For works that are not available on CCC please contact mpkbookspermissions@tandf.co.uk

Trademark notice: Product or corporate names may be trademarks or registered trademarks and are used only for identification and explanation without intent to infringe.

ISBN: 9781032133874 (hbk)

ISBN: 9781032159362 (pbk)

ISBN: 9781003246374 (ebk)

DOI: 10.1201/9781003246374

Typeset in Times

by codeMantra

Contents

<i>Acknowledgments or Credits List</i>	vii
<i>Authors</i>	ix

1 Introduction	1
Significance of Blood Flow Imaging	1
Technologies for Blood Flow Imaging	2
History of scDCT Development	3
References	5
2 scDCT Methods	9
Principle	9
Instrumentation	13
Boundary Data Collection	15
Image Reconstruction	16
References	19
3 scDCT Validations and Applications	21
Testing and Validating in Standard Phantoms and Computer Simulations	21
Proof-of-Concept Validation	22
Full Noncontact Validation and Optimal SD Separations for Larger ROI	23
Optimal SD Separations When Using Iris Diaphragm for Smaller ROI	26
Optimal SD Separations Using sCMOS Camera	27
Validation of PST for Arbitrary Surface Geometry Acquisition	27
Validation on Human Infant Skulls	28
Application 1: Imaging of Brains	29
Assessing CBF in a Mouse	30
Assessing CBF in Rats	30
Neonatal Piglet CBF Recovery	34
Noninvasive Monitoring of Human Infant CBF	38
Application 2: Imaging of Burn/Wound Tissues	39
Application 3: Imaging of Mastectomy Skin Flaps	41

Recovery of Blood Flow Distributions during Mastectomy Reconstruction Surgery	42
Incorporating Measured Surface Curvatures by PST	42
Comparing scDCT and FA Imaging Equivalence for Judging Mastectomy Skin Flap Status	44
References	46
4 Summary and Future Perspectives	49
References	50
<i>Index</i>	53