

PROCEEDINGS OF SPIE

Sensing for Agriculture and Food Quality and Safety IV

**Moon S. Kim
Shu-I Tu
Kuanglin Chao**
Editors

**24–25 April 2012
Baltimore, Maryland, United States**

Sponsored and Published by
SPIE

Volume 8369

Proceedings of SPIE, 0277-786X, v. 8369

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

Sensing for Agriculture and Food Quality and Safety IV, edited by Moon S. Kim, Shu-I Tu, Kuanglin Chao,
Proc. of SPIE Vol. 8369, 836901 · © 2012 SPIE · CCC code: 0277-786X/12/\$18 · doi: 10.1117/12.977869

Proc. of SPIE Vol. 8369 836901-1

The papers included 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. The papers published in these proceedings 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 this book:

Author(s), "Title of Paper," in *Sensing for Agriculture and Food Quality and Safety IV*, edited by Moon S. Kim, Shu-I Tu, Kuanglin Chao, Proceedings of SPIE Vol. 8369 (SPIE, Bellingham, WA, 2012) Article CID Number.

ISSN 0277-786X

ISBN 9780819490476

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 © 2012, 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 \$18.00 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/12/\$18.00.

Printed in the United States of America.

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



SPIDigitalLibrary.org

Paper Numbering: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first 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, print, and electronic versions of the publication. SPIE uses a six-digit CID article numbering system in which:

- The first four 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. The complete citation is used on the first page, and an abbreviated version on subsequent pages. Numbers in the index correspond to the last two digits of the six-digit CID number.

Contents

vii Conference Committee

SESSION 1 OPTICAL SENSING FOR AGRICULTURE I

- 8369 03 **Preliminary results of radiometric measurements of clear air and cloud brightness (antenna) temperatures at 37GHz** [8369-02]
A. K. Arakelyan, Armenian National Academy of Sciences (Armenia); A. K. Hambaryan, A. A. Arakelyan, ECOSERV Remote Observation Ctr. Co. Ltd. (Armenia)
- 8369 05 **Biomass estimator for NIR image with a few additional spectral band images taken from light UAS** [8369-04]
I. Pölönen, H. Salo, Univ. of Jyväskylä (Finland); H. Saari, VTT Technical Research Ctr. of Finland (Finland); J. Kaivosoja, L. Pesonen, MTT Agrifood Research Institute Finland (Finland); E. Honkavaara, Finnish Geodetical Institute (Finland)
- 8369 06 **Development of filter exchangeable 3CCD camera for multispectral imaging acquisition** [8369-05]
H. Lee, Seoul National Univ. (Korea, Republic of) and USDA Agricultural Research Service (United States); S. H. Park, Seoul National Univ. (Korea, Republic of); M. S. Kim, USDA Agricultural Research Service (United States); S. H. Noh, Seoul National Univ. (Korea, Republic of)
- 8369 07 **A non-rigid registration method for multispectral imaging of plants** [8369-06]
J. De Vylder, K. Douterloigne, F. Vandenbussche, D. Van Der Straeten, W. Philips, Ghent Univ. (Belgium)

SESSION 2 HYPERSPECTRAL IMAGING

- 8369 08 **The development of the line-scan image recognition algorithm for the detection of frass on mature tomatoes** [8369-07]
C.-C. Yang, M. S. Kim, P. Millner, K. Chao, D. E. Chan, USDA Agricultural Research Service (United States)
- 8369 09 **Hyperspectral imaging for detection of non-O157 Shiga-toxin producing *Escherichia coli* (STEC) serogroups on spread plates of mixed cultures** [8369-08]
S. C. Yoon, W. R. Windham, S. Ladely, G. W. Heitschmidt, K. C. Lawrence, B. Park, USDA Agricultural Research Service (United States) N. Narang, W. C. Cray, USDA Food Safety and Inspection Service (United States)
- 8369 0A **Improving prediction of total viable counts in pork based on hyperspectral scattering technique** [8369-09]
F. Tao, Y. Peng, Y. Song, H. Guo, China Agricultural Univ. (China); K. Chao, USDA Agricultural Research Service (United States)

- 8369 OB **Utilizing fluorescence hyperspectral imaging to differentiate corn inoculated with toxigenic and atoxigenic fungal strains** [8369-10]
H. Yao, Z. Hruska, R. Kincaid, Mississippi State Univ. (United States); R. L. Brown, D. Bhatnagar, T. E. Cleveland, USDA Agricultural Research Service (United States)

SESSION 3 OPTICAL SENSING FOR AGRICULTURE II

- 8369 OC **Polymer-based sensor array for phytochemical detection** [8369-11]
K. A. Weerakoon, N. Hiremath, B. A. Chin, Auburn Univ. (United States)
- 8369 OD **On-line detection of orange soluble solid content using visible and near infrared transmission measurements** [8369-12]
X. Fu, Y. Ying, H. Xu, B. Qi, L. Xie, Zhejiang Univ. (China)
- 8369 OE **Development of a single-channel, three-view imaging system with classification model for defect and damage assessment of freefalling cereal grains** [8369-13]
I.-C. Yang, National Science Council (Taiwan); S. R. Delwiche, USDA Agricultural Research Service (United States); Y. M. Lo, Univ. of Maryland, College Park (United States)
- 8369 OF **3D imaging of tomato seeds using frequency domain optical coherence tomography** [8369-14]
C. Fan, G. Yao, Univ. of Missouri-Columbia (United States)
- 8369 OG **The optical properties of onion dry skin and flesh at the wavelength 632.8 nm** [8369-15]
W. Wang, C. Li, The Univ. of Georgia (United States)

SESSION 4 RAMAN FOR FOOD QUALITY AND SAFETY

- 8369 OH **Detecting multiple adulterants in dry milk using Raman chemical imaging** [8369-16]
J. Qin, K. Chao, M. S. Kim, USDA Agricultural Research Service (United States)
- 8369 OI **Rapid detection of pesticide residue in apple based on Raman spectroscopy** [8369-17]
Y. Li, Y. Sun, Y. Peng, S. Dhakal, China Agricultural Univ. (China); K. Chao, USDA Agricultural Research Service (United States); Q. Liu, China Agricultural Univ. (China)
- 8369 OJ **In-situ identification of meat from different animal species by shifted excitation Raman difference spectroscopy** [8369-18]
K. Sowoidnich, H.-D. Kronfeldt, Technische Univ. Berlin (Germany)
- 8369 OK **Rapid analysis of foodborne pathogens by surface-enhanced Raman spectroscopy** [8369-19]
A. Sengupta, C. Shende, H. Huang, S. Farquharson, F. Inscore, Real-Time Analyzers, Inc. (United States)

SESSION 5 SENSING FOR PATHOGENS

- 8369 0L **Classification of Shiga toxin-producing escherichia coli (STEC) serotypes with hyperspectral microscope imagery (Invited Paper)** [8369-20]
B. Park, W. R. Windham, USDA Agricultural Research Service (United States); S. R. Ladely, USDA Food Safety and Inspection Service (United States); P. Gurram, H. Kwon, U. S. Army Research Lab. (United States); S-C. Yoon, K. C. Lawrence, USDA Agricultural Research Service (United States); N. Narang, W. C. Cray, USDA Food Safety and Inspection Service (United States)
- 8369 0N **Rapid, enhanced detection of *Salmonella Typhimurium* on fresh spinach leaves using micron-scale, phage-coated magnetoelastic biosensors** [8369-22]
S. Horikawa, K. A. Vaglenov, D. M. Gerken, Y. Chai, M.-K. Park, S. Li, V. A. Petrenko, B. A. Chin, Auburn Univ. (United States)
- 8369 0O **Identification and characterization of *Salmonella* serotypes using DNA spectral characteristics by fourier transform infrared (FT-IR) spectroscopy** [8369-23]
J. Sundaram, B. Park, A. Hinton, S. C. Yoon, K. C. Lawrence, USDA Agricultural Research Service (United States)

SESSION 6 BIOSENSORS FOR PATHOGENS

- 8369 0Q **Impedance biosensor based on interdigitated electrode array for detection of *E.coli* O157:H7 in food products** [8369-25]
S. Ghosh Dastider, Univ. of Missouri-Columbia (United States); S. Barizuddin, M. Dweik, Lincoln Univ. (United States); M. F. Almasri, Univ. of Missouri-Columbia (United States)

POSTER SESSION

- 8369 0T **Hyperspectral-imaging-based techniques applied to wheat kernels characterization** [8369-28]
S. Serranti, D. Cesare, G. Bonifazi, Univ. di Roma (Italy)
- 8369 0U **Dried fruits quality assessment by hyperspectral imaging** [8369-29]
S. Serranti, A. Gargiulo, G. Bonifazi, Univ. di Roma (Italy)
- 8369 0V **Construction of a cell-based sensor for the detection of autoinducer-2** [8369-30]
M. D. Servinsky, P. C. Allen, C.-Y. Tsao, U.S. Army Research Lab. (United States); C. M. Byrd, Univ. of Maryland, College Park (United States); C. J. Sund, U.S. Army Research Lab. (United States); W. E. Bentley, Univ. of Maryland, College Park (United States)
- 8369 0W **An investigation of FT-Raman spectroscopy for quantification of additives to milk** [8369-31]
Y. Cheng, National Taiwan Univ. (Taiwan); J. Qin, USDA Agricultural Research Service (United States); J. Lim, National Academy of Agricultural Engineering (Korea, Republic of); D. E. Chan, M. S. Kim, K. Chao, USDA Agricultural Research Service (United States)

- 8369 0X **Integration of independent component analysis with near infrared spectroscopy for evaluation of rice freshness** [8369-32]
Y.-K. Chuang, National Taiwan Univ. (Taiwan) and Univ. of Maryland, College Park (United States) and USDA Agricultural Research Service (United States); S. Chen, National Taiwan Univ. (Taiwan); S. R. Delwiche, USDA Agricultural Research Service (United States); Y. M. Lo, Univ. of Maryland, College Park (United States); C.-Y. Tsai, National Taiwan Univ. (Taiwan); I.-C. Yang, Univ. of Maryland, College Park (United States) and USDA Agricultural Research Service (United States); Y.-P. Hu, National Taiwan Univ. (Taiwan)
- 8369 0Y **Classification of Korla fragrant pears using NIR hyperspectral imaging analysis** [8369-33]
X. Rao, Zhejiang Univ. (China); C.-C. Yang, USDA Agricultural Research Service (United States); Y. Ying, Zhejiang Univ. (China); M. S. Kim, K. Chao, USDA Agricultural Research Service (United States)
- 8369 0Z **Capsaicinoids content prediction model development for Korean red-pepper powder using a visible and near-infrared spectroscopy** [8369-34]
J. Lim, C. Mo, National Academy of Agricultural Science (Korea, Republic of); S. H. Noh, Seoul National Univ. (Korea, Republic of); S. Kang, K. Lee, National Academy of Agricultural Science (Korea, Republic of); M. S. Kim, USDA Agricultural Research Service (United States)
- 8369 12 **Nondestructive prediction of pork freshness parameters using multispectral scattering images** [8369-37]
X. Tang, C. Li, Y. Peng, China Agricultural Univ. (China); K. Chao, USDA Agricultural Research Service (United States); M. Wang, China Agricultural Univ. (China)

Author Index

Conference Committee

Symposium Chair

Kevin P. Meiners, Office of the Secretary of Defense (United States)

Symposium Cochair

Kenneth R. Israel, Lockheed Martin Corporation (United States)

Conference Chairs

Moon S. Kim, USDA Agricultural Research Service (United States)

Shu-I Tu, USDA Agricultural Research Service (United States)

Kuanglin Chao, USDA Agricultural Research Service (United States)

Program Committee

Arun K. Bhunia, Center for Food Safety Engineering (United States)

Suming Chen, National Taiwan University (Taiwan)

Bryan Allen Chin, Auburn University (United States)

Byoung-Kwan Cho, Chungnam National University (Korea, Republic of)

Stephen R. Delwiche, USDA Agricultural Research Service (United States)

Ki-Bok Kim, Korea Research Institute of Standards and Science (Korea, Republic of)

Naoshi Kondo, Kyoto University Graduate School of Agriculture (Japan)

Kurt C. Lawrence, USDA Agricultural Research Service (United States)

Kangjin Lee, National Academy of Agriculture Science (Korea, Republic of)

Alan M. Lefcourt, USDA Agricultural Research Service (United States)

Renfu Lu, USDA Agricultural Research Service (United States)

Bosoon Park, USDA Agricultural Research Service (United States)

Yankun Peng, China Agricultural University (China)

Yang Tao, University of Maryland, College Park (United States)

Gang Yao, University of Missouri-Columbia (United States)

Haibo Yao, Mississippi State University (United States)

Yibin Ying, Zhejiang University (China)

Seung Chul Yoon, USDA Agricultural Research Service (United States)

Session Chairs

- 1 Optical Sensing for Agriculture I
 Seung Chul Yoon, USDA Agricultural Research Service (United States)
- 2 Hyperspectral Imaging
 Haibo Yao, Mississippi State University (United States)
- 3 Optical Sensing for Agriculture II
 Gang Yao, University of Missouri-Columbia (United States)
- 4 Raman for Food Quality and Safety
 Kuanglin Chao, Agricultural Research Service (United States)
- 5 Sensing for Pathogens
 Suiqiong Li, Auburn University (United States)
- 6 Biosensors for Pathogens
 Bryan Allen Chin, Auburn University (United States)