

# PROCEEDINGS OF SPIE

[SPIDigitalLibrary.org/conference-proceedings-of-spie](https://spiedigitallibrary.org/conference-proceedings-of-spie)

## Front Matter: Volume 7321

Proceedings of SPIE

Proceedings of SPIE, "Front Matter: Volume 7321," Proc. SPIE 7321, Bio-Inspired/Biomimetic Sensor Technologies and Applications, 732101 (20 May 2009); doi: 10.1117/12.833493

**SPIE.**

Event: SPIE Defense, Security, and Sensing, 2009, Orlando, Florida, United States

PROCEEDINGS OF SPIE

# ***Bio-Inspired/Biomimetic Sensor Technologies and Applications***

**Nicholas F. Fell, Jr.**  
**Venkataraman S. Swaminathan**  
*Editors*

**13–14 April 2009**  
**Orlando, Florida, United States**

*Sponsored and Published by*  
SPIE

**Volume 7321**

Proceedings of SPIE, 0277-786X, v. 7321

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

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 *Bio-Inspired/Biomimetic Sensor Technologies and Applications*, edited by Nicholas F. Fell, Jr., Venkataraman S. Swaminathan, Proceedings of SPIE Vol. 7321 (SPIE, Bellingham, WA, 2009) Article CID Number.

ISSN 0277-786X  
ISBN 9780819475879

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 © 2009, 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](http://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/09/\$18.00.

Printed in the United States of America.

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

**SPIE**   
Digital Library

[SPIDigitalLibrary.org](http://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 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	<i>Conference Committee</i>
ix	<i>Introduction</i>

---

## SESSION 1 SENSORS

---

- 7321 03 **Optimization of a multi-well array SERS chip** [7321-03]  
J. L. Abell, J. D. Driskell, R. A. Dluhy, R. A. Tripp, Y.-P. Zhao, The Univ. of Georgia (United States)
- 7321 04 **Detection of immunocomplex formation by enhanced photoluminescence of antibody-functionalized diatom biosilica** [7321-04]  
D. K. Gale, Oregon State Univ. (United States); T. Gutu, J. Jiao, Portland State Univ. (United States); C.-H. Chang, G. L. Rorrer, Oregon State Univ. (United States)
- 7321 05 **Engineering new aptamer geometries for electrochemical aptamer-based sensors** [7321-05]  
R. J. White, K. W. Plaxco, Univ. of California, Santa Barbara (United States)
- 7321 06 **Approaches to detection of airborne biological agents** [7321-06]  
A.-C. Chang, M. B. Tabacco, Smiths Detection (United States)

---

## SESSION 2 ACOUSTIC DETECTION

---

- 7321 07 **Biomimetic smart sensors for autonomous robotic behavior I: acoustic processing (Invited Paper)** [7321-07]  
S. Deligeorges, S. Xue, A. Soloway, L. Lichtenstein, T. Gore, BioMimetic Systems, Inc. (United States); A. Hubbard, Boston Univ. (United States) and BioMimetic Systems, Inc. (United States) and The Boston Univ. Photonics Ctr. (United States)
- 7321 08 **Biomimetic smart sensors for autonomous robotic behavior II: vestibular processing** [7321-08]  
S. Xue, S. Deligeorges, A. Soloway, L. Lichtenstein, T. Gore, BioMimetic Systems, Inc. (United States); A. Hubbard, Boston Univ. (United States) and BioMimetic Systems, Inc. (United States) and The Boston Univ. Photonics Ctr. (United States)

- 7321 09 **Biologically inspired circuitry that mimics mammalian hearing** [7321-09]  
 A. Hubbard, Boston Univ. (United States) and BioMimetic Systems, Inc. (United States) and The Boston Univ. Photonics Ctr. (United States); H. Cohen, Boston Univ. (United States); C. Karl, Boston Univ. (United States) and BioMimetic Systems, Inc. (United States) and Intel, Inc. (United States); D. Freedman, Boston Univ. (United States); D. Mountain, BioMimetic Systems, Inc. (United States) and Boston Univ. (United States); L. Ziph-Schatzberg, The Boston Univ. Photonics Ctr. (United States); M. Nourzad Karl, Intel, Inc. (United States) and Boston Univ. (United States); S. Kelsall, Boston Univ. (United States); T. Gore, Boston Univ. (United States) and BioMimetic Systems, Inc. (United States); Y. Pu, Boston Univ. (United States); Z. Yang, Boston Univ. (United States) and Intel, Inc., (United States); X. Xing, Boston Univ. (United States); S. Deligeorges, Boston Univ. (United States) and Systems, Inc. (United States)
- 7321 0A **Fly-ear inspired acoustic sensors for gunshot localization** [7321-10]  
 H. Liu, Univ. of Maryland, College Park (United States); L. Currano, Univ. of Maryland, College Park (United States) and Army Research Lab. (United States); D. Gee, Army Research Lab. (United States); B. Yang, M. Yu, Univ. of Maryland, College Park (United States)
- 7321 0B **Microscale implementation of a bio-inspired acoustic localization device** [7321-11]  
 L. J. Currano, Army Research Lab. (United States); H. Liu, Univ. of Maryland, College Park (United States); D. Gee, Army Research Lab. (United States) and Univ. of Maryland, College Park (United States); B. Yang, M. Yu, Univ. of Maryland, College Park (United States)

---

**SESSION 3 LOCOMOTION AND ROBOTICS**

---

- 7321 0E **Bio-inspired locomotion for a modular snake robot** [7321-14]  
 S. Zhang, Y. Guo, Stevens Institute of Technology (United States)

---

**SESSION 4 ALGORITHMS**

---

- 7321 0F **GeoTrack: bio-inspired global video tracking by networks of unmanned aircraft systems (Invited Paper)** [7321-15]  
 P. Barooah, Univ. of Florida (United States); G. E. Collins, Toyon Research Corp. (United States); J. P. Hespanha, Univ. of California, Santa Barbara (United States)
- 7321 0G **A comparison of foveated acquisition and tracking performance relative to uniform resolution approaches** [7321-16]  
 S. Dubuque, T. Coffman, 21st Century Technologies, Inc. (United States); P. McCarley, Air Force Research Lab. (United States); A. C. Bovik, Univ. of Texas at Austin (United States); C. W. Thomas, 21st Century Technologies, Inc. (United States)
- 7321 0H **Fuzzy logic and coarse coding using programmable logic devices** [7321-17]  
 G. Brooks, Florida State Univ., Panama City (United States)

**POSTER SESSION**

---

- 7321 OI **Bio-inspired synthesis and laser processing of nanostructured barium titanate thin films: implications for uncooled IR sensor development** [7321-02]  
F. E. Livingston, The Aerospace Corp. (United States); W. L. Sarney, Army Research Lab. (United States); K. Niesz, T. Ould-Ely, A. R. Tao, D. E. Morse, Univ. of California, Santa Barbara (United States)

*Author Index*



# Conference Committee

## *Symposium Chair*

**Ray O. Johnson**, Lockheed Martin Corporation (United States)

## *Symposium Cochair*

**Michael T. Eismann**, Air Force Research Laboratory (United States)

## *Conference Chairs*

**Nicholas F. Fell, Jr.**, Army Research Laboratory (United States)

**Venkataraman S. Swaminathan**, U.S. Army Research, Development and Engineering Command (United States)

## *Program Committee*

**Joanna Aizenberg**, Harvard University (United States)

**Guillermo C. Bazan**, University of California, Santa Barbara (United States)

**Socrates Deligeorges**, BioMimetic Systems, Inc. (United States)

**Frank Doyle**, University of California, Santa Barbara (United States)

**Madan Dubey**, Army Research Laboratory (United States)

**James S. Humbert**, University of Maryland, College Park (United States)

**Daniel E. Morse**, University of California, Santa Barbara (United States)

**Richard M. Murray**, California Institute of Technology (United States)

**Rajesh R. Naik**, Air Force Research Laboratory (United States)

**Paul M. Pellegrino**, Army Research Laboratory (United States)

**Tien Pham**, Army Research Laboratory (United States)

**Paul D. Willson**, U.S. Army Armament Research, Development and Engineering Center (United States)

## *Session Chairs*

1 Sensors

**Venkataraman S. Swaminathan**, U.S. Army Research, Development and Engineering Command (United States)

2 Acoustic Detection

**Nicholas F. Fell, Jr.**, Army Research Laboratory (United States)



- 3 Locomotion and Robotics  
**Paul M. Pellegrino**, Army Research Laboratory (United States)
- 4 Algorithms  
**Socrates Deligeorges**, BioMimetic Systems, Inc. (United States)

## Introduction

Bioinspired/biomimetic technologies are a fast growing field that attempts to take advantage of the plethora of ideas and models in nature that work to an extraordinary degree of perfection. One application of immediate relevance of bioinspired technologies is to develop smart sensor systems that employ a heterogeneous group of multi-modal sensors, and perform real time processing and communication of data. With increasing emphasis on the Size, Weight and Power and Cost (SwaP-C) requirements for deployed systems, it is imperative that future sensor platforms take advantage of processes/mechanisms found in nature to design miniaturized electronic, optical and computational systems. These sensor systems must leverage biomimetic models of the animal/insect world to enable substantial reduction in processing requirements and to achieve real time operation.

The conference included sixteen papers organized into four technical sessions consisting of Sensors, Acoustic Detection, Locomotion and Robotics, and Algorithms. One of the sixteen papers was presented as a poster in the poster session. Each session included an invited paper by a leading expert in the field. The following invited papers were presented:

- Super-bright, stable, reproducible, SERS biotags for simultaneous identification of multiple biomarkers by Professor Martin Moskovits (Univ. of California, Santa Barbara)
- Biomimetic smart sensors for autonomous robotic behavior part I: acoustic processing by Dr Socrates Deligeorges (BioMimetic Systems, Inc.)
- Mechanisms of frictional adhesion in biological adhesion and locomotion by Professor Jacob Israelachvili (Univ. of California, Santa Barbara)
- GeoTrack: global video tracking by networks of unmanned aircraft systems by Dr Prabir Barooah (Univ. of Florida)

We thank all the authors for their presentations and all the participants for a successful first symposium on Bioinspired/Biomimetic Sensor Technologies and Applications. We thank all the Program Committee members for their assistance in conference planning and organizing. Our thanks to all the session chairs. Last but not the least, our special thanks to SPIE staff for their dedication and help in organizing the symposium.

We hope that the conference theme will continue to generate interest and bring together researchers working in the multiple areas of biology, engineering, the physical sciences and medicine in applying designs and processing models inspired from biological systems to realize microsensor systems that provide

unprecedented situational awareness meeting concurrently the SWaP-C requirements.

**Nicholas F. Fell, Jr.**  
**Venkataraman S. Swaminathan**