

IEEE Signal Processing MAGAZINE

Volume 33 | Number 4 | July 2016

MOOC ADVENTURES IN SIGNAL PROCESSING

Acoustic Microphone
Geometry Calibration

Mobile Image Processing
for Health Monitoring

Continuous User Authentication

Application-Oriented Hands-On
Activities for SP Courses

Contents

Volume 33 | Number 4 | July 2016

FEATURES

14 ACOUSTIC MICROPHONE GEOMETRY CALIBRATION

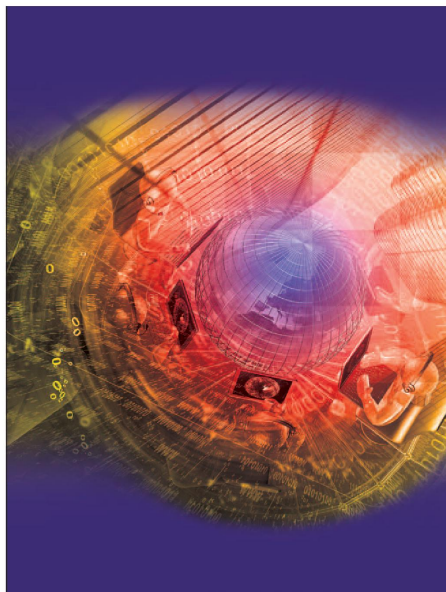
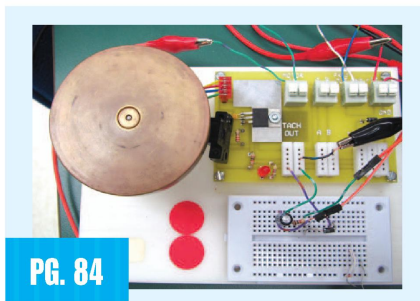
Axel Plinge, Florian Jacob, Reinhold Haeb-Umbach, and Gernot A. Fink

30 SMARTPHONE AND MOBILE IMAGE PROCESSING FOR ASSISTED LIVING

Hossein Nejati, Victor Pomponiu, Thanh-Toan Do, Yiren Zhou, Sahar Iravani, and Ngai-Man Cheung

49 CONTINUOUS USER AUTHENTICATION ON MOBILE DEVICES

Vishal M. Patel, Rama Chellappa, Deepak Chandra, and Brandon Barbello



ON THE COVER

The last four years have witnessed an explosion of interest and activity in massive open online courses (MOOCs). Online teaching has caused much debate, mostly because of its undeniably disruptive nature with respect to the standard college education paradigm. Check out the article on page 62, as the authors share their collective experiences and insights learned through the design, development, delivery, and management of online DSP courses.

COVER IMAGE: ©ISTOCKPHOTO.COM/ARCHERIX

62 MOOC ADVENTURES IN SIGNAL PROCESSING

Thomas A. Baran, Richard G. Baraniuk, Alan V. Oppenheim, Paolo Prandoni, and Martin Vetterli

COLUMNS

6 Society News

New Society Officer Elected for 2017 and Nominations Open for 2016 SPS Awards

8 Reader's Choice

Top Downloads in IEEE Xplore

10 Special Reports

Signal Processing Plays a Key Role in Wireless Research
John Edwards

84 SP Education

Lessons Learned from Implementing Application-Oriented Hands-On Activities for Continuous-Time Signal Processing Courses
Mario Simoni and Maurice Aburdene

90 Life Sciences

Understanding and Predicting Epilepsy
Christophe Bernard

96 Tips & Tricks

A General Design Method for FIR Compensation Filters in Δ - Σ ADCs
Zhe Chen, Shuwen Wang, and Fuliang Yin



IEEE SIGNAL PROCESSING MAGAZINE (ISSN 1053-5888) (ISPREG) is published bimonthly by the Institute of Electrical and Electronics Engineers, Inc., 3 Park Avenue, 17th Floor, New York, NY 10016-5997 USA (+1 212 419 7900). Responsibility for the contents rests upon the authors and not the IEEE, the Society, or its members. Annual member subscriptions included in Society fee. Nonmember subscriptions available upon request. **Individual copies:** IEEE Members US\$20.00 (first copy only), nonmembers US\$213.00 per copy. Copyright and Reprint Permissions: Abstracting is permitted with credit to the source. Libraries are permitted to photocopy beyond the limits of U.S. Copyright Law for private use of patrons: 1) those post-1977 articles that carry a code at the bottom of the first page, provided the per-copy fee indicated in the code is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923 USA; 2) pre-1978 articles without fee. Instructors are permitted to photocopy isolated articles for noncommercial classroom use without fee. **For all other copying, reprint, or republication permission,** write to IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08854 USA. Copyright © 2016 by the Institute of Electrical and Electronics Engineers, Inc. All rights reserved. Periodicals postage paid at New York, NY, and at additional mailing offices. **Postmaster:** Send address changes to IEEE Signal Processing Magazine, IEEE, 445 Hoes Lane, Piscataway, NJ 08854 USA. Canadian GST #125634188 **Printed in the U.S.A.**

Digital Object Identifier 10.1109/MSP.2016.2547159

3 From the Editor

Journey of Learning
Min Wu

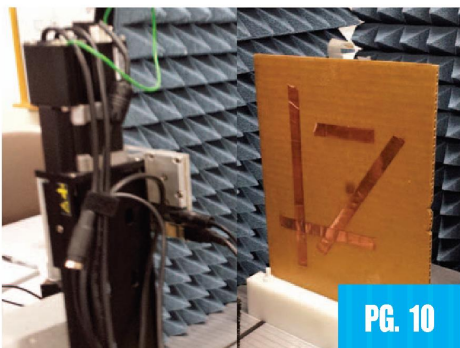
4 President's Message

Bringing Signal Processing into the Forefront
of the Conversation
Rabab Ward

104 Dates Ahead

©ISTOCKPHOTO.COM/TONDA

ICIP 2016 will be held in Phoenix, Arizona, United States,
25-28 September.

**EDITOR-IN-CHIEF**

Min Wu—University of Maryland, College Park
U.S.A.

AREA EDITORS**Feature Articles**

Shuguang Robert Cui—Texas A&M University,
U.S.A.

Special Issues

Douglas O'Shaughnessy—INRS, Canada

Columns and Forum

Kenneth Lam—Hong Kong Polytechnic University,
Hong Kong SAR of China

e-Newsletter

Christian Debes—TU Darmstadt and
AGT International, Germany

Social Media and Outreach

Andres Kwasinski—Rochester Institute
of Technology, U.S.A.

EDITORIAL BOARD

Mritunjoy Chakraborty—Indian Institute of
Technology, Kharagpur, India

George Chrisikos—Qualcomm, Inc.,
U.S.A.

Patrick Flandrin—ENS Lyon, France

Mounir Ghogho—University of Leeds,
U.K.

Lina Karam—Arizona State University, U.S.A.

Hamid Krim—North Carolina State University,
U.S.A.

Sven Lončarić—University of Zagreb, Croatia

Brian Lovell—University of Queensland, Australia

Jian Lu—Qihoo 360, China

Henrique (Rico) Malvar—Microsoft Research,
U.S.A.

Yi Ma—ShanghaiTech University, China

Stephen McLaughlin—Heriot-Watt University,
Scotland

Athina Petropulu—Rutgers University,
U.S.A.

Peter Ramadge—Princeton University,
U.S.A.

Shigeki Sagayama—Meiji University, Japan

Erchin Serpedin—Texas A&M University,
U.S.A.

Shihab Shamma—University of Maryland,
U.S.A.

Hing Cheung So—City University of Hong Kong,
Hong Kong

Isabel Trancoso—INESC-ID/Instituto Superior
Técnico, Portugal

Pramod K. Varshney—Syracuse University,
U.S.A.

Z. Jane Wang—The University of British
Columbia, Canada

Gregory Wornell—Massachusetts Institute
of Technology, U.S.A.

Dapeng Wu—University of Florida, U.S.A.

ASSOCIATE EDITORS—COLUMNS AND FORUM

Ivan Bajić—Simon Fraser University, Canada

Rodrigo Capobianco Guido—
São Paulo State University, Brazil

Ching-Te Chiu—National Tsing Hua University,
Taiwan

Michael Gormish—Ricoh Innovations, Inc.

Xiaodong He—Microsoft Research

Danilo Mandić—Imperial College, U.K.

Aleksandra Mojsilović—

IBM T.J. Watson Research Center

Fatih Porikli—MERL

Shantanu Rane—PARC, U.S.A.

Saeid Sanei—University of Surrey, U.K.

Roberto Togneri—The University of
Western Australia

Alessandro Vinciarelli—IDIAP-EPFL

Azadeh Vosoughi—University of Central Florida

Stefan Winkler—UIUC/ADSC, Singapore

ASSOCIATE EDITORS—e-NEWSLETTER

Csaba Benedek—Hungarian Academy
of Sciences, Hungary

Paolo Braca—NATO Science and Technology
Organization, Italy

Quan Ding—University of California,
San Francisco, U.S.A.

Pierluigi Failla—Compass Inc, New York,
U.S.A.

Marco Guerriero—General Electric Research,
U.S.A.

Yang Li—Harbin Institute of Technology, China

Yuhong Liu—Penn State University at Altoona,
U.S.A.

Andreas Merentitis—University of Athens, Greece

Michael Muma—TU Darmstadt, Germany

Xiaorong Zhang—San Francisco State University,
U.S.A.

ASSOCIATE EDITOR—SOCIAL MEDIA/OUTREACH

Guijin Wang—Tsinghua University, China

IEEE SIGNAL PROCESSING SOCIETY

Rabab Ward—President

Ali Sayed—President-Elect

Carlo S. Regazzoni—Vice President, Conferences

Konstantinos (Kostas) N. Plataniotis—

Vice President, Membership

Thrasylvoulos (Thrasos) N. Pappas—

Vice President, Publications

Walter Kellerman—Vice President,
Technical Directions

IEEE SIGNAL PROCESSING SOCIETY STAFF

Denise Hurley—Senior Manager of Conferences
and Publications

Rebecca Wollman—Publications Administrator

IEEE PERIODICALS MAGAZINES DEPARTMENT

Jessica Barragué, *Managing Editor*

Geraldine Krolin-Taylor, *Senior Managing Editor*

Mark David, *Senior Manager*

Advertising and Business Development

Felicia Spagnoli, *Advertising Production Manager*

Janet Dudar, *Senior Art Director*

Gail A. Schnitzer, Mark Morrissey,

Associate Art Directors

Theresa L. Smith, *Production Coordinator*

Dawn M. Melley, *Editorial Director*

Peter M. Tuohy, *Production Director*

Fran Zappulla, *Staff Director,*

Publishing Operations

Digital Object Identifier 10.1109/MSP.2016.2547160



www.sfi-program.org
SFI-01042

IEEE prohibits discrimination, harassment, and bullying.

For more information, visit

<http://www.ieee.org/web/aboutus/whatis/policies/p9-26.html>.

SCOPE: IEEE Signal Processing Magazine publishes tutorial-style articles on signal processing research and applications as well as columns and forums on issues of interest. Its coverage ranges from fundamental principles to practical implementation, reflecting the multidimensional facets of interests and concerns of the community. Its mission is to bring up-to-date, emerging and active technical developments, issues, and events to the research, educational, and professional communities. It is also the main Society communication platform addressing important issues concerning all members.