

# IEEE SIGNAL PROCESSING SOCIETY

The Signal Processing Society is an organization, within the framework of the IEEE, of members with principal professional interest in the technology of transmission, recording, reproduction, processing, and measurement of speech; other audio-frequency waves and other signals by digital electronic, electrical, acoustic, mechanical, and optical means; the components and systems to accomplish these and related aims; and the environmental, psychological, and physiological factors of these technologies. All members of the IEEE are eligible for membership in the Society upon payment of the annual Society membership fee. For more information on joining, visit <https://www.ieee.org/membership/join>.

## IEEE OPEN JOURNAL OF SIGNAL PROCESSING

MARI OSTENDORF, *Editor-in-Chief*, University of Washington, Seattle, WA, USA

### ADVISORY/EDITORIAL BOARD

CORINNA CORTES  
Google Research  
New York, NY, USA

ZHI-QUAN (TOM) LUO  
Chinese University of Hong Kong  
Shenzhen, China

H. VINCENT POOR  
Princeton University  
Princeton, NJ, USA

W. CLEM KARL  
Boston University  
Boston, MA, USA

URBASHI MITRA  
University of Southern California  
Los Angeles, CA, USA

ANNA SCAGLIONE  
Arizona State University  
Tempe, AZ, USA

BJORN OTTERSTEN  
Université du Luxembourg  
Luxembourg, U.K.

### ASSOCIATE EDITORS

SELIN AVIYENTE  
Michigan State University  
East Lansing, MI, USA

PAOLO BANELLI  
Univ. Degli Studi di Perugia  
Perugia, Italy

MAURO BARNI, *Senior Area Editor*  
University of Siena  
Siena, Italy

ASLI CELIKYILMAZ  
Microsoft Research  
Redmond, WA, USA

TSUNG-HUI CHANG  
The Chinese University of Hong Kong,  
Shenzhen  
Hong Kong, Shenzhen, China

ARSENIA CHORTI  
Ecole Nationale Supérieure de  
l'Electronique et de ses Applications  
Cergy, France

PHILIPPE CIUCIU, *Senior Area Editor*  
CEA  
Gif Sur Yvette, France

FERNANDO CRUZ-ROLDÁN  
Universidad de Alcalá  
Madrid, Spain

PETER DJURIC, *Senior Area Editor*  
Stony Brook University  
New York, NY, USA

ZHIGUO DING  
Univ. Manchester  
Manchester, U.K.

PAULO S. R. DINIZ, *Senior Area Editor*  
Universidade Federal do Rio de Janeiro  
Rio de Janeiro, Brazil

ZEKERIYA ERKIN  
Delft University of Technology Delft,  
North Holland, The Netherlands

PASCAL FROSSARD  
EPFL  
Lausanne, Switzerland

JOSHI GAURI, *Consulting Associate Editor*  
Carnegie Mellon University  
Pittsburgh, PA, USA

VIVEK GOYAL  
Boston University  
Boston, MA, USA

MINGYI HONG, *Consulting Associate Editor*  
University of Minnesota  
Minneapolis, MN, USA

USMAN KHAN  
Tufts University  
Medford, MA, USA

BIN LI  
Shenzhen University  
Shenzhen, China

KAREN LIVESCU  
TTI-Chicago  
Chicago, IL, USA

ANGSHUL MAJUMDAR  
IIT Delhi India  
Dahli, India

CHRISTOS MASOUIROS  
Univ. College London  
London, U.K.

VINCENZO MATTA  
Univ. Degli Studi di Salerno  
Fisciano, Italy

ERIC MILLER  
Tufts University  
Medford, MA, USA

DANILO ORLANDO  
Università Degli Studi Niccolò Cusano  
Fisciano, Italy

ANA ISABEL PÉREZ-NEIRA,  
*Senior Area Editor*  
Technical University of Catalonia  
Catalonia, Spain

MARIUS PESAVENTO, *Senior Area Editor*  
Technische Universität Darmstadt  
Darmstadt, Germany

EMILY MOWER PROVOST  
University of Michigan  
Ann Arbor, MI, USA

STEVE RENALS, *Senior Area Editor*  
University of Edinburgh  
Edinburgh, U.K.

CÉDRIC RICHARD  
Université Côte d'Azur, France  
Côte d'Azur, France

MICHAEL RILEY, *Senior Area Editor*  
Google  
New York, NY, USA

CHRISTOPHER ROZELL  
Georgia Institute of Technology  
Atlanta, GA, USA

ANAND SARWATE, *Consulting Associate Editor*  
Rutgers, The State University of New Jersey  
Piscataway, NJ, USA

HIROSHI SAWADA  
Nippon Telegraph and Telephone  
Tokyo, Japan

RAFAEL SCHAEFER,  
*Consulting Associate Editor*  
Technische Universität Berlin  
Berlin, Germany

FABIO SCOTTI  
Univ. Degli Studi di Milano  
Milano, Italy

PARIS SMARAGDIS, *Senior Area Editor*  
University of Illinois,  
Urbana-Champaign  
Urbana-Champaign, IL, USA

VENUGOPAL V. VEERAVALLI,  
*Senior Area Editor*  
University of Illinois,  
Urbana-Champaign  
Urbana-Champaign, IL, USA

ANTHONY VETRO, *Senior Area Editor*  
Mitsubishi Electric Research Labs  
(MERL)  
Cambridge, MA, USA

YAO WANG  
Rutgers, The State University of New Jersey  
Piscataway, NJ, USA

JASON WILLIAMS  
Apple  
Seattle, WA, USA

H. VICKY ZHAO  
Tsinghua University  
Beijing, China

### IEEE Officers

TOSHIO FUKUDA, *President*  
SUSAN K. "KATHY" LAND, *President-Elect*  
KATHLEEN A. KRAMER, *Secretary*  
JOSEPH V. LILLIE, *Treasurer*  
JOSE M. F. MOURA, *Past President*

STEPHEN M. PHILLIPS, *Vice President, Educational Activities*  
TAPAN K. SARKAR, *Vice President, Publication Services and Products*  
KUKJIN CHUN, *Vice President, Member and Geographic Activities*  
ROBERT S. FISH, *President, Standards Association*  
KAZUHIRO KOSUGE, *Vice President, Technical Activities*  
JAMES M. CONRAD, *President, IEEE-USA*

REBAB KREIDIEH, *Director, Division IX—Signals and Application*

### IEEE Executive Staff

STEPHEN P. WELBY, *Executive Director & Chief Operating Officer*

THOMAS SIEGERT, *Business Administration*  
JULIE EVE COZIN, *Corporate Governance*  
DONNA HOURICAN, *Corporate Strategy*  
JAMIE MOESCH, *Educational Activities*  
SOPHIA A. MUIRHEAD, *General Counsel & Chief Compliance Officer*  
LIESEL BELL, *Human Resources*  
CHRIS BRANTLEY, *IEEE-USA*

CHERIF AMIRAT, *Information Technology*  
KAREN HAWKINS, *Marketing*  
CECELIA JANKOWSKI, *Member and Geographic Activities*  
MICHAEL FORSTER, *Publications*  
KONSTANTINOS KARACHALIOS, *Standards Association*  
MARY WARD-CALLAN, *Technical Activities*

### IEEE Publishing Operations

*Senior Director, Publishing Operations:* DAWN MELLELY  
*Director, Editorial Services:* KEVIN LISANKIE *Director, Production Services:* PETER M. TUOHY  
*Associate Director, Editorial Services:* JEFFREY E. CICHOCKI *Associate Director, Information Conversion and Editorial Support:* NEELAM KHINVASARA  
*Manager, Journals Production:* KATIE SULLIVAN *Journals Production Manager:* SHANNON N. CAMPOS

IEEE OPEN JOURNAL OF SIGNAL PROCESSING (ISSN 2644-1322) is published by the Institute of Electrical and Electronics Engineers, Inc. Responsibility for the contents rests upon the authors and not upon the IEEE, the Society/Council, or its members. **IEEE Corporate Office:** 3 Park Avenue, 17th Floor, New York, NY 10016-5997. **IEEE Operations Center:** 445 Hoes Lane, Piscataway, NJ 08854-4141. **NJ Telephone:** +1 732 981 0060. Member and nonmember subscription prices available upon request. All rights reserved.

IEEE prohibits discrimination, harassment, and bullying. For more information, visit <https://www.ieee.org/about/corporate/governance/p9-26.html>. This journal is 100% open access, which means that all content is freely available without charge to users or their institutions. All articles accepted after 12 June 2019 are published under a CC BY 4.0 license\*, and the author retains copyright. Users are allowed to read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, as long as proper attribution is given. Open access is provided through the payment of an article processing charge (APC) paid after acceptance. APCs are often financed by an author's institution or the funder supporting their research.

\*Articles accepted before 12 June 2019 were published under a CC BY 3.0 or the IEEE Open Access Publishing Agreement license. Questions about copyright policies or reuse rights may be directed to the IEEE Intellectual Property Rights Office at +1-732-562-3966 or [copyrights@ieee.org](mailto:copyrights@ieee.org).

The articles in this journal are peer reviewed in accordance with the requirements set forth in the IEEE PSPB Operations Manual (sections 8.2.1.C & 8.2.2.A). Each published article was reviewed by a minimum of two independent reviewers using a single-blind peer review process, where the identities of the reviewers are not known to the authors, but the reviewers know the identities of the authors. Articles will be screened for plagiarism before acceptance.