

IEEE SENSORS JOURNAL

The IEEE SENSORS JOURNAL is published by the IEEE Sensors Council, which is sponsored by 26 IEEE societies (see the inside back cover). For membership and subscription information and pricing, please visit <https://www.ieee.org/membership-catalog>. *Member copies of Transactions/Journals are for personal use only.*

Editor-in-Chief (2024-present)

ZEYNEP CELIK
Electrical Engineering Department
University of Texas at Arlington
Arlington, TX 76019 USA

Past Editor-in-Chief (2018-2024)

SANDRO CARRARA
Biomedical Circuits & Systems
École Polytechnique Fédérale
de Lausanne (EPFL)
Lausanne, CH-1015 Switzerland

Past Editor-in-Chief (2011-2018)

KRIKOR B. OZANYAN
Photonic Sensors and Systems
Univ. of Manchester
Sch. Elect. & Electron. Eng.
Manchester, M13 9PL U.K.

Past Editor-in-Chief (2009-2011)

EVGENY KATZ
Colloid Science Chemistry
& Biomolecular Sci.
Clarkson Univ.
Potsdam, NY 13699 USA

Past Editor-in-Chief (2003-2009)

H. TROY NAGLE
Electrical & Computer Engineering
NC State Univ.
Raleigh, NC 27695-7115 USA

Founding Editor-in-Chief (2001-2003)

VLADIMIR LUMELSKY
Mechanical Engineering,
Computer Science
Univ. of Wisconsin
Madison, WI 53706 USA

2026 Editorial Board

Associate Editors-in-Chief

MARCO JOSE DA SILVA
Johannes Kepler University Linz
Austria
CARLOS RUIZ ZAMARREÑO
Public University of Navarra,
Spain

Sensor Systems Integration

Topical Editor
YANG YANG
Chinese Academy of
Sciences, China
MEHMET YUCE
Monash Univ.
Victoria, Australia

Sensor Applications

Topical Editors
PAI-YEN CHEN
Univ. of Illinois Chicago, USA
MARYAM SHOJAEI BAGHINI
Indian Institute of Technology
Bombay, India

Mechanical, Magnetic, and

Thermal Sensors

WEILEUN FANG
National Tsing Hua Univ.,
Taiwan

Chemical & Biosensors

Sensor Materials

Topical Editor
CAMILLA BARATTO
National Institute
of Optics (INO)
Brescia, Italy

Sensor Phenomena and Modelling

Topical Editor
TARIKUL ISLAM
Jamia Millia Islamia
New Delhi 110025, India
**Optoelectronic, Microwave, and
Fiber-Optic Sensors**
Topical Editors
MINGHONG YANG
Wuhan University of Technology, China
QIANG WU
Northumbria Univ., U.K.

Sensor Data Processing

Topical Editors
PIERLUIGI SALVO ROSSI
Norwegian University of
Science and Technology, Norway
DONG WANG
Shanghai Jiao Tong University, China
**Sensor Interface Electronics
and System Networks**
Topical Editor
CHANG-HEE WON
Temple University, USA

Topical Editor-at-Large

JOHN R. VIG
Consultant
33 Bucks Mill Rd.
Colts Neck, NJ 07722 USA
Intelligent Sensors
Topical Editors
AHISH PANDHARIPANDE
Signify
Eindhoven, AE, The Netherlands
ANDRÉ EUGENIO LAZZARETTI
Universidade Tecnológica Federal
do Paraná, Brazil

MAINAK ADHIKARI
Indian Inst. of Science
Education and Research, India
BARBARA ADINOLFI
Inst. of Applied Physics, Italy
MOHAMMED JALCH AHAMED
Univ. of Windsor, Canada
MAHMOUD ALMASRI
Univ. of Missouri, USA
IBRAHEEM AL-NAIB
King Fahd Univ. of Petroleum
and Minerals, Saudi Arabia
VANITA ARORA
SS Automation Solutions Private Limited,
India
MOHSEN ASADINA
Macquarie Univ., Australia
MASOUD BAGHELANI
Ilam Univ., Iran
VARUN BAJAJ
PDPM Indian Inst. of Information
Technology Design and
Manufacturing Jabalpur, India
MUHAMMED ENEŞ BAYRAKDAĞ
Duzce University, Turkey
SHARMISTHA BHADRA
McGill Univ., Canada
PARTHA BHATTACHARYYA
Indian Inst. of Engineering
Science and Technology, India
RAHUL BHATTACHARYYA
MIT Auto-ID Labs, USA
BASANTA BHOWMIK
NIT Jamshedpur, India
KARABI BISWAS
Indian Inst. of Technology Kharagpur, India
HUNG CAO
Univ. of California Irvine, USA
LINGA REDDY CENKERAMADDI
Univ. of Agder, Norway
CHINMAY CHAKRABORTY
Kalinga Inst. of Industrial
Technology (KIIT), India
LUBIN CHANG
Naval Univ. of Engineering, China
LIANG-BI CHEN
National Penghu Univ. of Science
and Technology, Taiwan
YUEJIAN CHEN
Univ. of Manitoba, Canada
HUANYU (LARRY) CHENG
The Pennsylvania State Univ., USA
XI CHENG
Tianjin Univ. of Technology, China
YING-REN CHEN
National Taipei Univ. of Technology,
Taiwan
JOÃO PAULO J. DA COSTA
Hamm-Lippstadt Univ. of Applied
Sciences, Germany
QINGSONG CUI
New Mexico Inst. of Mining and
Technology, USA
WALTENEĞÜS DARGIE
TU Dresden, Germany
EGIDIO DE BENEDETTO
Univ. of Naples Federico II, Italy
FLORENC DEMIROZI
Univ. of Stavanger, Norway
SAYAN DEY
Indian Inst. of Technology, India
SAAKSHI DHANEKAR
Indian Inst. of Technology Jodhpur, India
D. K. DWIVEDI
Madan Mohan Malaviya Univ.
of Technology, India
AMIR EBRAHIMI
RMIT Univ., Australia
SEYDEH AIDA (AIDA) EBRAHIMI
Pennsylvania State Univ., USA
LAURA FABBIANO
Polytechnic of Bari, Univ., Italy
TAI FEI
Univ. of Applied Sciences and
Art Dortmund, Germany
KE FENG
National Univ. of Singapore, Singapore
GIANCARLO FORTINO
Università della Calabria, Italy
HAILING FU
Beijing Inst. of Technology, China
BIN GAO
Univ. of Electronic Science
and Technology of China, China
JOSEPH GREETHU
TU Delft, Netherlands
BOBY GEORGE
Indian Inst. of Technology
Madras, India

SANKET GOEL
BITS-Pilani, India
TANER GÖKTA DOKUZ EYLÜL Univ., Turkey
VINAY CHAKRAVARTHI GOGINENI
NTNU-Trondheim, Norway
CHINTHAKA P. GOONERATNE
Indian Inst. of Technology, Madras, India
BENOIT GOSSELIN
Université Laval, Canada
FUQIANG GU
Chongqing Univ., China
PRASANTA KUMAR GUHA
Indian Inst. of Technology (IIT)
- Kharagpur, India
SHISHENG GUO
Univ. of Electronic Science
and Technology, China
HAMIDA HALLIL
Univ. of Bordeaux, France
DONGSOO HAR
KAIST, Korea
XUEHAO HU
University of Mons, Belgium
CHENG-SHENG (JASON) HUANG
National Yang Ming Chiao
Tung Univ., Taiwan
XINTAO HUAN
Beijing Inst. of Technology, China
WEI-CHEN HUANG
National Yang Ming Chiao Tung
Univ., Taiwan
YULONG HUANG
Harbin Engineering Univ., China
CHUNG-CHIH (FRANK) HUNG
National Yang Ming Chiao Tung
Univ., Taiwan
RAJAN JHA
Indian Inst. of Technology (IIT)
Bhubaneswar, India
BOWEN JI
Northwestern Polytechnical Univ., China
YUCHEN JIANG
Harbin Inst. of Technology, China
HAORAN JIN
Zhejiang Univ., China
DEEPAK JOSHI
Indian Inst. of Technology (IIT)
Delhi, India
SUNGYONG JUNG
South Dakota State Univ., USA
SRINIVASA RAO KARUMURI
Koneru Lakshmaiah Education
Foundation, India
SHAKIB AHMAD KHAN
Jamia Millia Islamia (JMI), India
QURESHI KHURRAM
King Fahd Univ. of Petroleum & Minerals,
Saudi Arabia
YOUNGWOOK KIM
Sogang Univ., South Korea
AJAY KOTAPALLI
Rijksuniversiteit Groningen
Faculteit voor Wetkunde en
Natuurwetenschappen, Netherlands
HALUK KÜLAH
Middle East Technical Univ., Turkey
MAHESH KUMAR
Indian Inst. of Technology, India
NAGESWARA LAL
US Department of Energy, USA
GIACOMO LANGFELDER
Politecnico di Milano, Italy
ARNALDO G. LEAL JUNIOR
Universidade Federal do Espírito
Santo, Brazil
CHING-HUNG LEE
National Yang Ming Chiao Tung Univ.,
Taiwan
HSIN-YING LEE
National Cheng Kung Univ.,
Taiwan
HUANG CHEN LEE
National Chung Cheng Univ.,
Taiwan
JEONG BONG (JB) LEE
Baylor Univ., USA
SANG-SEOK LEE
Tottori Univ., Japan
SEONGWOOK LEE
Chung-Ang Univ., Republic of Korea
YUN-JU LEE
National Tsing Hua Univ., Taiwan
JUAN ANTONIO LEÑERO BARDALLO
Univ. of Seville, Spain
GUOFA LI
Chongqing Univ., China
NAN LI
Xidian Univ., China

QILIAN LI
George Mason Univ., USA
QING LI
Anhui Agricultural Univ., China
SHENG-SHAN LI
National Tsing Hua Univ., Taiwan
TAO LI
University of Cincinnati, USA
WEIHUA LI
South China Univ. of Technology,
China
YANG LI
Northwestern Polytechnical Univ., China
YIFAN LI
Southwest Jiaotong Univ., China
YONGBO LI
Northwestern Polytechnical Univ., China
HONGJIA LI
Infineon Austria, Austria
ZENGKE LI
China Univ. of Mining and
Technology, China
CHANGRUI LIAO
Shenzhen Univ., China
YI LIAO
Univ. of Electronic Science and
Technology of China, China
YU-TE LIAO
National Yang Ming Chiao Tung Univ.,
Taiwan
CHIH-TING LIN
National Taiwan Univ., Taiwan
HSIEN-LIN LIN
National Yang Ming Chiao
Tung Univ., Taiwan
YU-CHENG LIN
National Cheng Kung Univ.,
Taiwan
DATONG LIU
Harbin Inst. of Technology, China
LIANSHENG LIU
Liaoning Institute of
Technology, China
HAIYAN LIU
China Univ. of Geosciences, China
YI-HUNG LIU
National Yang Ming Chiao Tung
Univ., Taiwan
ZHILIANG LIU
Univ. of Electronic Science
and Technology of China, China
XI LONG
Eindhoven Univ. of Technology
(TU/e), The Netherlands
SUN LI
Chinese Academy of Sciences, China
SILIANG LU
Anhui Univ., China
ALESSANDRO LUCHETTI
Univ. of Trento, Italy
GUOXING MA
North China Electric Power Univ., China
YONGHAO MIAO
Beihang Univ., China
REZA MAJIDI
Malmo Univ., Sweden
DHIMAN MALLICK
Indian Inst. of Technology Delhi, India
NIRUPAMA MANDAL
Indian Inst. of Technology (ISM)
Dhanbad, India
ENGIN MASAZADE
Marmara Univ., Turkey
CARLO MASSARONI
Università Campus Bio-Medico
di Roma (UCBM), Italy
HAIGEN MIN
Chang'an Univ., China
RUI MIN
Beijing Normal Univ., China
SATYENDRA KUMAR MISHRA
SRCOM CITC, Spain
ATEF MOHAMED
United Arab Emirates Univ.,
United Arab Emirates
HYEJIN MOON
Univ. of Texas at Arlington, USA
ROSARIO MORELLO
Univ. Mediterranea di
Reggio Calabria, Italy
AMRIT MUKHERJEE
Univ. of South Bohemia, Czech Republic
SHAILI MUKHERJEE
Indian Inst. of Technology
Indore, India

RAVIBABU MULAVEESALA
Indian Inst. of Technology Ropar, India
ANINDYA NAG
Technische Univ. Dresden, Germany
ZAHRA NASIRI-GHEIDARI
Sharif Univ. Technology, Iran
XU BO NGUYEN
National Yang Ming Chiao Tung
Univ., Taiwan
QING NI
Univ. of Technology Sydney, Australia
DANILLO ORLANDO
Univ. degli Studi di Pisa, Italy
XIAOPENG PAN
Shenzhen Univ., China
OM JEE PANDEY
IIT (BHU) Varanasi, India
LING PEI
Shanghai Jiao Tong Univ., China
DANDAN PENG
Hong Kong Polytechnic Univ., Hong Kong
DAVID PLETTS
imec-Ghent Univ., Belgium
R. N. PONNALAGU
BITS Pilani, India
YOGENDRA KUMAR PRAJAPATI
Mottal Nehru National Inst.
of Technology Allahabad, India
JUNHUI QIAN
Chongqing Univ., China
YI QIN
Chongqing Univ., China
MUHAMMAD MAHBOOB UR RAHMAN
Information Technology Univ., Pakistan
GINU RAJAN
Cardiff Metropolitan Univ., U.K.
JEAN-MICHEL REDOUTÉ
Univ. of Liege, Belgium
MAJID ROSHANFAR
The Hospital for Sick Children, Canada
SUNIPA ROY
Krishnagar Women's College, India
TAKUYA SAKAMOTO
Kyoto Univ., Japan
FABRIZIO SANTI
Sapienza Univ. of Rome, Italy
AVIK SANTRA
Infineon Technologies, Germany
THILO SAUTER
Danube Univ. Krems, Austria
EMILIANO SCHENA
Univ. Campus Bio-Medico
di Roma, Italy
HAIDONG SHI
Hunan Univ., China
CHANGQING SHEN
Soochow Univ., China
JUANJUAN SHI
Soochow Univ., China
WEI-CHUAN SHIH
Univ. of Houston, USA
ANAND MOHAN SHRIVASTAV
SRM Inst. of Science and Technology, India
JITENDRA SINGH
CSIR-CEERI Pilani, India
NUTAPON SOMJIT
Pollard Inst. U.K.
LIUYANG SONG
Beijing Univ. of Chemical
Technology, China
PEI SONG
Universiti Tunku Abdul Rahman
(UTAR), Malaysia
MARIOS SOPHOCLEOUS
eBOS Technologies Ltd, Cyprus
K. SRIDHARAN
Indian Inst. of Technology Madras, India
SACHIN KUMAR SRIVASTAVA
Indian Inst. of Technology
Roorkee, India
NAGENDER KUMAR SURYADEVARA
Univ. of Hyderabad, India
SHAWANA TABASSUM
UT Tyler, USA
JERRY TAI
National Yang Ming Chiao Tung Univ.,
Taiwan
CHAO TAN
Tianjin Univ., China
WEI TANG
New Mexico State Univ., USA

TAO TANG
Chinese Academy of Sciences, China
DIPANWITA THAKUR
Univ. of Calabria, Italy
ANTREAS THEODOSIOU
Lumiscor LTD, Cyprus
GUI YUN TIAN
Univ. of Electronic Science
and Technology of China, China
MONIKA TOMAR
Univ. of Delhi, India
KAGAN TOPALLI
Astranis Space Technologies Corp., USA
MUSTAFA MERT TORUNBALCI
Broadcom Inc., USA
DANIELE TOSI
Nazarbayev Univ., Kazakhstan
TSUNG-HONG TSAI
National Yang Ming Chiao Tung Univ., Taiwan
JOHAN WAHLSTRÖM
University of Exeter, Sweden
BO WANG
Hamad Bin Khalifa Univ., Qatar
JIACHENG WANG
Nanyang Technological Univ., Singapore
JUN WANG
Soochow Univ., China
LIN WANG
Queen Mary Univ. of London, U.K.
GAO WANG
Anhui Univ., China
YU-JEN WANG
National Sun Yat-sen Univ., Taiwan
WEI WEI
Xi'an Univ. of Technology, China
XIAOYU WANG
China Three Gorges Univ., China
CHANG-HEE WON
Temple Univ., USA
KAI WU
Univ. of South Florida, USA
HONG XIAOBIN
South China Univ. of Technology, China
YUEDONG XIE
Beihang University, China
YUYONG XIONG
Shanghai Jiao Tong Univ., China
WEI XU
Shenzhen Univ., China
CHEN YANG
Beihang Univ., China
MING YANG
Guizhou Univ., China
ZHUOQING YANG
Shanghai Jiao Tong Univ. (SJTU), China
HER-TERNG YAU
National Chung Cheng Univ., Taiwan
WENBIN YE
Shenzhen Univ., China
LEVENT YOBAS
Hong Kong Univ. of Science and Technology,
Hong Kong
RUI YUAN
Wuhan Univ. of Science and Technology,
China
JAIME ZABALZA
Univ. of Strathclyde, U.K.
MOHAMMAD HOSEIN ZARIFI
Univ. of British Columbia, Canada
DAWEI ZHANG
Zhejiang Normal Univ., China
YU-DONG ZHANG
Univ. of Leicester, U.K.
XIAOJIN ZHAO
Shenzhen Univ., China
XIAOLI ZHAO
Nanjing Univ. of Science
and Technology, China
YONGQIANG ZHAO
Northwestern Polytechnical
Univ., China
MU ZHOU
Chongqing Univ. of Posts
and Telecommunications, China
XIAOSHAN (SEAN) ZHU
Univ. of Nevada Reno, USA
YONG ZHU
Griffith Univ., Australia
ZHENGYU ZHU
Zhengzhou Univ., China
MUHAMMAD ZUBAIR
Univ. of Leicester, U.K.

IEEE Publishing Operations

Senior Director, Publishing Operations: DAWN MELLEY

Director, Editorial Services: KEVIN LISANKIE Director, Production Services: PETER M. TUOHY

Associate Director, Digital Assets & Editorial Support: NEELAM KHINVASARA

Senior Manager, Journals Production: PATRICK KEMPF Journals Production Manager: EILEEN MCGUINNESS

IEEE SENSORS JOURNAL (ISSN 1558-1748) is published semimonthly 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. **IEEE Operations Center:** 445 Hoes Lane, Piscataway, NJ 08854. **NJ Telephone:** +1 732 981 0060. **Price/Publication Information:** Member and nonmember subscription prices available upon request. **Copyright and Reprint Permissions:** Abstracting is permitted with credit to the source. Libraries are permitted to photocopy for private use of patrons, provided the per-copy fee of \$31.00 is paid through the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. For all other copying, reprint, or republication permission, write to Copyrights and Permissions Department, IEEE Publications Administration, 445 Hoes Lane, Piscataway, NJ 08854. Copyright © 2026 by The Institute of Electrical and Electronics Engineers, Inc. All rights reserved. IEEE prohibits discrimination, harassment and bullying. For more information visit <http://www.ieee.org/nondiscrimination>.