

# IEEE SYSTEMS, MAN, AND CYBERNETICS SOCIETY

The IEEE SYSTEMS, MAN, AND CYBERNETICS Society is an organization within the framework of the IEEE, with professional interest in the closely interrelated fields of man-machine systems, systems science, systems engineering, and cybernetics. All members of the IEEE are eligible for membership in the Society upon payment of the annual Society membership fee of \$12.00. Members may receive SMC upon payment of an additional \$20.00 (\$32.00 total), TCYB upon payment of an additional \$22.00 (\$34.00 total), and THMS for an additional \$16.00 (\$28.00 total). Members of certain other professional societies are eligible to become Affiliates of the Society. For information on joining, write to the IEEE at the address below. *Member copies of Transactions/Journals are for personal use only.*

## Board of Governors

<i>President</i> EDDIE TUNSTEL						<i>Jr. Past President</i> DIMITAR FILEV	<i>Sr. Past President</i> LJILJANA TRAJKOVIC
<i>Vice President Conferences and Meetings</i> MENGCHU ZHOU	<i>Vice President Cybernetics</i> SAM KWONG	<i>Vice President Finance</i> FERAT SAHIN	<i>Vice President Human-Machine Systems</i> ANDREAS NUERNBERGER	<i>Vice President Membership and Student Activities</i> ADRIAN STOICA	<i>Vice President Organization and Planning</i> VLADIMIR MARIK	<i>Vice President Publications</i> ENRIQUE HERRERA VIEDMA	<i>Vice President Systems Science and Engineering</i> RODNEY ROBERTS
<i>Secretary</i> MENGCHU ZHOU	<i>Treasurer</i> ROBERT WOON						

### Term ending 2018

MARIA PIA FANTI  
KEITH W. HIPEL  
OKYAY KAYNAK  
ROBERT KOZMA  
HIDEYUKI TAKAGI

### Term ending 2019

GYORGY EIGNER  
ENRIQUE HERRERA VIEDMA  
KAREN PANETTA  
CHING-CHIH TSAI  
FEI-YUE WANG

### Term ending 2020

GIANCARLO FORTINO  
DAVID MENDONCA  
TADAHIKO MURATA  
PNG SHI  
THOMAS I. STRASSER

## IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS

### Editor-in-Chief

C. L. PHILIP CHEN  
Faculty of Science and Technology  
The University of Macau  
Macau, China  
Fax: (853) 8822-2426

## ASSOCIATE EDITORS

S. AGAIAN	F. CHICLANA	Y. HATA	L. L. LAI	D. MARIAGRAZIA	L. SHEREMETOV	E. USAI	Z.-G. WU
C. KI AHN	T.-M. CHOI	W. HE	H.-X. LI	J. MCCALL	C. J. F. SILVESTRE	F.-Y. WANG	S. XIE
D. AKOPIAN	J.-H. CHOU	E. HERRERA-VIEDMA	HONGYI LI	S. MOSTAGHIM	S. SONG	Q. WANG	C. G. YANG
S. BANDYOPADHYAY	R. CUI	K. HIPEL	T. LI	S. NAHAVANDI	Y. SONG	X. WANG	Q. M. YANG
A. BARGIELA	F. DENG	K. HIROTA	Z. LI	G. NICOSIA	Y. D. SONG	Z. WANG	X. YOU
J.-P. BARTHES	B. DERBEL	W. HSU	C.-C. LIM	D. OLSON	F. SUN	ZIDONG WANG	W. YU
M. V. BASIN	Y. DONG	D. HU	C.-T. LIN	M. S. PALANISWAMI	J. SUN	Q. WEI	Z. W. YU
G. CABRI	L. FANG	K. HUANG	Y. LIU	K. PANETTA	W. C. SUN	G. H. WEN	D. YUE
M. CELENK	M. P. FANTI	X. P. HUANG	Z. LIU	W. PEDRYCZ	H. TIANFIELD	R. WISNIEWSKI	D. ZHANG
W. K. V. CHAN	J. FU	Y. KANG	Z. G. LIU	X. PENG	M. K. TIWARI	K. WOLF	W. J. CHRIS ZHANG
B. CHEN	Q. GE	H. R. KARIMI	V. LOIA	R. ROBERTS	S. TONG	B.-F. WU	X. ZHAO
E. CHEN	S. S. GE	M. V. KOTHARE	J. LOZANO	J. SARANGAPANI	A. TRAPPEY	D. S. WU	Y. ZHAO
L. CHEN	P. GUO	R. KUMAR	J. LU	K. T. SEOW	C.-C. TSAI	H.-N. WU	H. ZHU
M. CHEN	Y. HAO	J. KURTHS	J. LU	W. SHEN	E. TUNSTEL	X. Y. WU	

## IEEE Officers

JOSÉ M. F. MOURA, *President*  
TOSHIO FUKUDA, *President-Elect*  
KATHLEEN KRAMER, *Secretary*  
JOSEPH V. LILLIE, *Treasurer*  
JAMES A. JEFFERIES, *Past President*  
WITOLD M. KINSNER, *Vice President, Educational Activities*  
HULYA KIRKICI, *Vice President, Publication Services and Products*  
FRANCIS B. GROSZ, JR., *Vice President, Member and Geographic Activities*  
ROBERT S. FISH, *President, Standards Association*  
K. J. RAY LIU, *Vice President, Technical Activities*  
THOMAS M. COUGHLIN, *President, IEEE-USA*

LJILJANA TRAJKOVIC, *Director, Division X*

## 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*  
VACANT, *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 MELLEY  
*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  
*Managing Editor:* CHRISTOPHER PERRY *Journals Coordinator:* CATHERINE VAN SCIVER

IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS (ISSN 2168-2216) is published monthly 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. **Price/Publication Information:** Individual copies: IEEE Members \$32.00 (first copy only), nonmembers \$45.00 per copy. (Note: Postage and handling charge not included.) 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 08854-4141. Copyright © 2019 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 TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS, IEEE, 445 Hoes Lane, Piscataway, NJ 08854-4141. GST Registration No. 125634188. CPC Sales Agreement #40013087. Return undeliverable Canada addresses to: Pitney Bowes IMEX, P.O. Box 4332, Stanton Rd., Toronto, ON M5W 3J4, Canada. IEEE prohibits discrimination, harassment and bullying. For more information visit <http://www.ieee.org/nondiscrimination>. Printed in U.S.A.