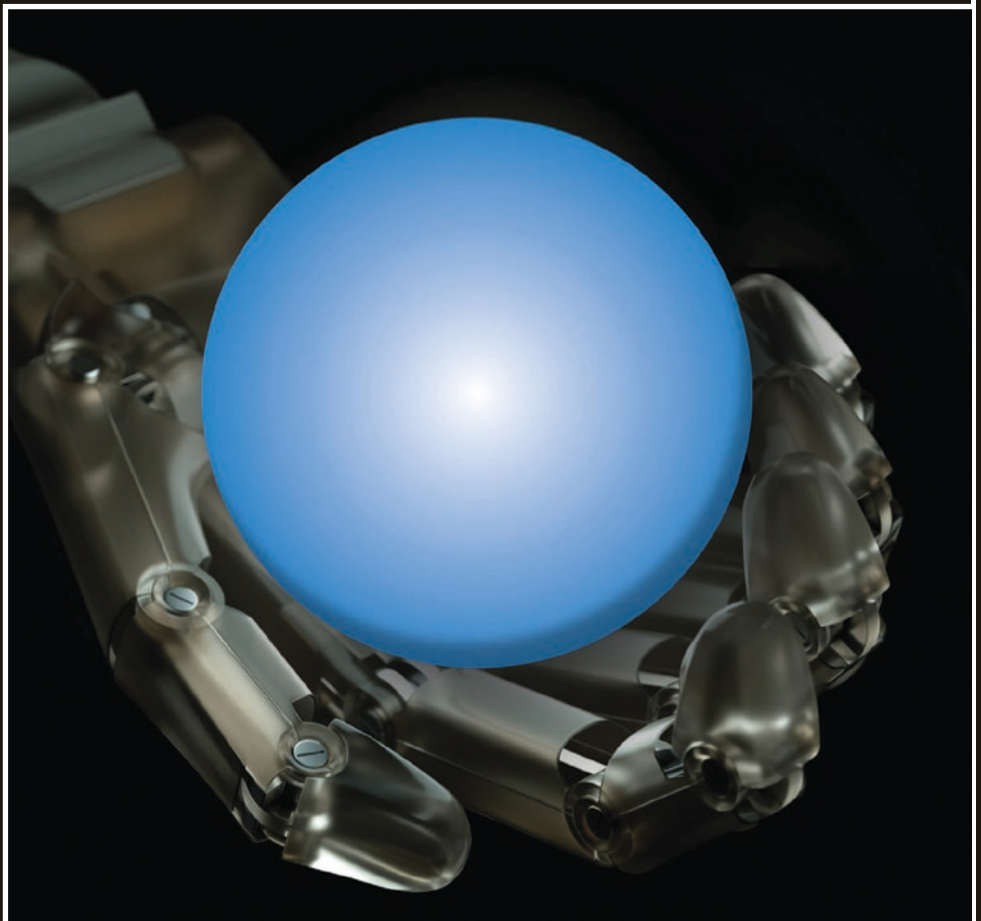


Volume 38 Part 6

# ROBOTICA



[cambridge.org/rob](http://cambridge.org/rob)

**CAMBRIDGE**  
UNIVERSITY PRESS

ISSN 0263-5747

# ROBOTICA

An IFAC-Affiliated Journal, and an  
Official Journal of the IFR.

International Journal of Information, Education and Research  
in Robotics and Artificial Intelligence

---

## EDITOR

Professor G.S. Chirikjian, *Department of Mechanical Engineering, National University of Singapore, Singapore and Johns Hopkins University Baltimore, MD USA*  
E-mail: [gregc@jhu.edu](mailto:gregc@jhu.edu)

---

## FOUNDING EDITOR

Professor J. Rose, (UK)

---

## EDITORIAL BOARD

Professor Srinivas Akella, *University of North Carolina at Charlotte, USA*  
Dr G.K. Ananthasuresh, *The Indian Institute of Science, Bangalore, India*

Professor Nikos A. Aspragathos, *University of Patras, Patras, Greece*  
Professor Eduardo Jose Bayro-Corrochano, *Universidad de Guadalajara, Mexico*

Professor Thomas Bock, *Technical University of Munich, Germany*  
Professor Giuseppe Carbone, *University of Calabria, Italy*  
Professor I-Ming Chen, *Nanyang Technological University, Singapore*  
Professor Howie Choset, *Carnegie Mellon University, Pittsburgh, USA*  
Professor Clément Gosselin, *Laval University, Canada*  
Dr Ambarish Goswami, *Honda Research Institute, USA*

Professor S. Hirose, *Tokyo Institute of Technology, Japan*  
Dr Tamas Kalmar-Nagy, *Mitsubishi Electric Research Lab, USA*  
Dr M. Kassler, *Michael Kassler & Associates, Pty, NSW, Australia*  
Professor F. Kececi, *Istanbul Technical University, Turkey*  
Professor G. Liu, *Ryerson University, Canada*  
Professor Todd D. Murphey, *Northwestern University, Evanston, Illinois, USA*  
Professor Frank Chongwoo Park, *Seoul National University, Seoul 151-742, Korea*  
Professor B. Siciliano, *University of Naples, Italy*  
Professor Nabil Simaan, *Vanderbilt University Nashville, TN, USA*  
Professor Jeff Trinkle, *Rensselaer Polytechnic Institute, USA*  
Professor Mark Yim, *University of Pennsylvania Philadelphia, USA*  
Professor Yu Zhou, *SUNY Stony Brook, USA*

*Robotica* aims to be an outlet for publication of original papers of the highest quality in the field of Robotics and closely related areas. This includes: novel robotic mechanism and actuator design; robot kinematics, dynamics and control; computer vision; sensor fusion; teleoperation and haptic interfaces; robot motion planning; and artificial intelligence. In addition, papers that apply techniques from Robotics to other fields are also welcome. Examples include dynamics and control models applied to biological systems, the description of implementations of robots in factories, service and agricultural settings, and general mechatronic design. Works may be theoretical, computational or experimental, or some combination. Both short papers (rapid communications), and longer archival papers are welcome. Proposals for special issues on topics of current interest are welcome, and can be submitted via email to the editor.

This journal issue has been printed on FSC-certified paper and cover board. FSC is an independent, non-governmental, not-for-profit organization established to promote the responsible management of the world's forests. Please see [www.fsc.org](http://www.fsc.org) for information.

© Cambridge University Press 2020

## SUBSCRIPTIONS

*Robotica* (ISSN 0263-5747) is published as twelve Issues per Volume in January, February, March, April, May, June, July, August, September, October, November and December. The electronic-only price for Volume 38, 2020 available to institutional subscribers is £1384 (US \$2444 in USA, Canada and Mexico). EU subscribers (outside the UK) who are not registered for VAT should add VAT at their country's rate. VAT registered subscribers should provide their VAT registration number. Orders, which

must be accompanied by payment, may be sent to a bookseller, subscription agent or direct to the publishers: Cambridge University Press, University Printing House, Shaftesbury Road, Cambridge CB2 8RU, UK. Orders from the USA, Canada and Mexico should be sent to Cambridge University Press, Journals Fulfillment Department, 1 Liberty Plaza, Floor 20, New York, NY 10006, USA. Japanese prices for institutions are available from Kinokuniya Company Ltd, P.O. Box 55, Chitose, Tokyo 156, Japan. Prices include delivery by air.

Periodicals postage paid at New York, NY and additional mailing offices. POSTMASTER: send address changes in USA, Canada and Mexico to *Robotica*, Cambridge University Press, 1 Liberty Plaza, Floor 20, New York, NY 10006, USA.

## COPYING

This journal is registered with the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923. Organizations in the USA who are also registered with CCC may therefore copy material (beyond the limits permitted by sections 107 and 108 of US copyright law) subject to payment to CCC of the per-copy fee of \$16.00. This consent does not extend to multiple copying for promotional or commercial purposes. Code 0263-5747/2020/\$16.00.

ISI Tear Sheet Service, 3501 Market Street, Philadelphia, Pennsylvania 19104, USA, is authorised to supply single copies of separate articles for private use only.

Organizations authorized by the Copyright Licensing Agency may also copy material subject to the usual conditions.

For all other use, permission should be sought from Cambridge or the American Branch of Cambridge University Press.

Information on *Robotica* and all other Cambridge journals can be accessed via [cambridge.org/core](http://cambridge.org/core).