THE ROYAL INSTITUTE OF NAVIGATION

Aims and Objects

The objects of the Institute are to unite in one body those who are concerned with or who are interested in navigation and to further its development. Navigation is conceived as applying to locomotion of all kinds and is perceived as encompassing aspects of: command and control, psychology and zoology, operational research, risk analysis, theoretical physics, operation in hostile environments, instrumentation, ergonomics, financial planning and law as well as electronics, astronomy, mathematics, cartography and other subjects traditionally associated with navigation.

The aims of the Institute are to encourage the creation and dissemination of knowledge through research and development, to co-ordinate information from all the disciplines involved, to provide a forum in which new ideas and new products can have the benefit of informed and professional scrutiny and to further education and communication. The Institute initiates conferences and symposia on specific subjects and has a programme of meetings at which lectures are given and discussed. There are standing Special Interest Groups (SIGs), which keep under constant review pertinent aspects of navigation. The success of these Special Interest Groups is crucially dependent on the active involvement of members

The SIGs include: Land Navigation and Location Group (LN&L), General Aviation Navigation Group (GANG), History of Air Navigation Group (HANG), Civil and Military Air Group (CMAG), Marine Traffic & Navigation Group (MT&NG), Small Craft Group (SCG), Space Group (Space), Animal Navigation Group (ANG) and Research & Development Group (R&D).

The Institute publishes *The Journal of Navigation* six times a year. It contains papers which have been presented at meetings, other original papers and selected papers and reports from Special Interest Groups. The Institute also publishes *Navigation News* six times a year which contains a full account of the Institute's proceedings and activities. This includes Branch News, a record of current navigational work, a diary of events, topical articles, news about Membership and advertising. A great deal of the Institute's work is international in character and is coordinated with that of similar organisations in other countries.

Membership

There are nine classes of membership under which individuals or organisations may apply to join the Institute. Details of the various membership criteria and current subscriptions are available on the RIN website (Home / Join the RIN / Membership Types http://www.rin.org.uk/general.aspx?ID=59) and from the Membership Secretary (membership@rin.org.uk Tel: +44(0)20 7591 3130 Fax: 44(0)20 7591 3131).

- (1) Ordinary Membership
- (2) Associate Membership
- (3) Associate Fellow Membership
- (4) Student Membership
- (5) Junior Associate Membership
- (6) Corporate Membership
- (7) Small Business Membership
- (8) Affiliate College University Membership
- (9) Affiliate Club Membership

Additional membership classes of Fellowship, Honorary Fellowship, Retired Membership and Affiliate Membership also exist and details are available from the Membership Secretary.

The subscription price (excluding VAT) to The Journal (ISSN 0373–4633) for Volume 71, 2018, which includes print and electronic access, is £635 (USA, Canada and Mexico US \$1147) and includes delivery by air; single parts are available at £115 (USA, Canada and Mexico US \$208) plus postage. The electronic-only price available to institutional subscribers is £492 (USA, Canada and Mexico US \$897). 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. The Journal is issued free to all Members of the Institute. Orders, which must be accompanied by payment, may be sent to any bookseller or subscription agent or direct to the publishers: Cambridge University Press, UPH, Shaftesbury Road, Cambridge CB2 8BS, or in the USA, Canada and Mexico 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.

© 2018 The Royal Institute of Navigation

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 for information.

THE JOURNAL OF NAVIGATION

VOLUME 71 NUMBER 5 SEPTEMBER 2018

CONTENTS

Enhancing Navigator Competence by Demonstrating Maritime Cyber Security Odd Sveinung Hareide, Øyvind Jøsok, Mass Soldal Lund, Runar Ostnes and Kirsi Helkala	1025
A Spatial, Temporal Complexity Metric for Tactical Air Traffic Control Hong Jie Wee, Sun Woh Lye and Jean-Philippe Pinheiro	1040
An Efficient Radio Map Updating Algorithm based on K-Means and Gaussian Process Regression Jianli Zhao, Xiang Gao, Xin Wang, Chunxiu Li, Min Song and Qiuxia Sun	1055
Orbit and Positioning Accuracy for New Generation Beidou Satellites during the Earth Eclipsing Period Xiaojie Li, Xiaogong Hu, Rui Guo, Chengpan Tang, Shanshi Zhou, Shuai Liu, and Jianbing Chen	1069
Space Flyaround and In-orbit Inspection Coupled Control Based on Dual Numbers Lijun Zhang, Hanqiu Li, Jianping Liu, Shan Qian, Yi Lu and Hengnian Li	1088
GNSS Spoofing Detection Technique Using Fraction Parts of Double-difference Carrier Phases Yanfeng Hu, Shaofeng Bian, Bing Ji and Juan Li	1111
A Review of Navigation Involving General Aviation Pilots Flying under Visual Flight Rules Elena Psyllou, Arnab Majumdar and Washington Ochieng	1130
A Feasibility Study of Applying Laser Line Scanning to AUV Hydrodynamic Parameter Identification Yu-Cheng Chou, Madoka Nakajima and Hsin-Hung Chen	1143
A Low Complexity Integrated Navigation System for Underwater Vehicles Mehdi Emami and Mohammad Reza Taban	1161
Joint Kinematic and Feature Tracking of Ships with Satellite Electronic Information Yong Liu, Libo Yao, Wei Xiong and Zhimin Zhou	1178
Visual Analytics Approach to Vessel Behaviour Analysis Liang Jin, Zhengyi Luo and Shu Gao	1195
Ship Trajectories Pre-processing Based on AIS Data Liangbin Zhao, Guoyou Shi and Jiaxuan Yang	1210
Air Data Estimation by Fusing Navigation System and Flight Control System Chen Lu, Rong-Bing Li, Jian-Ye Liu and Ting-Wan Lei	1231
Astronomical Vessel Heading Determination based on Simultaneously Imaging the Moon and the Horizon Jun-yu Pu, Chong-hui Li, Yong Zheng and Yin-hu Zhan	1247
Service and Evaluation of the GPS Triple-Frequency Satellite Clock Offset Haojun Li, Weidong Zhu, Rungen Zhao and Jiexian Wang	1263
The Journal of Navigation Instructions for Contributors	1274



