Advances in Signal Processing and Intelligent Recognition Systems

Advances in Intelligent Systems and Computing

Volume 425

Series editor

Janusz Kacprzyk, Polish Academy of Sciences, Warsaw, Poland
e-mail: kacprzyk@ibspan.waw.pl
About this Series

The series “Advances in Intelligent Systems and Computing” contains publications on theory, applications, and design methods of Intelligent Systems and Intelligent Computing. Virtually all disciplines such as engineering, natural sciences, computer and information science, ICT, economics, business, e-commerce, environment, healthcare, life science are covered. The list of topics spans all the areas of modern intelligent systems and computing.

The publications within “Advances in Intelligent Systems and Computing” are primarily textbooks and proceedings of important conferences, symposia and congresses. They cover significant recent developments in the field, both of a foundational and applicable character. An important characteristic feature of the series is the short publication time and world-wide distribution. This permits a rapid and broad dissemination of research results.

Advisory Board

Chairman
Nikhil R. Pal, Indian Statistical Institute, Kolkata, India
e-mail: nikhil@isical.ac.in

Members
Rafael Bello, Universidad Central “Marta Abreu” de Las Villas, Santa Clara, Cuba
e-mail: rbellop@uclv.edu.cu
Emilio S. Corchado, University of Salamanca, Salamanca, Spain
e-mail: escorcho@usal.es
Hani Hagras, University of Essex, Colchester, UK
e-mail: hani@essex.ac.uk
László T. Kóczy, Széchenyi István University, Győr, Hungary
e-mail: koczy@sze.hu
Vladik Kreinovich, University of Texas at El Paso, El Paso, USA
e-mail: vladik@utep.edu
Chin-Teng Lin, National Chiao Tung University, Hsinchu, Taiwan
e-mail: ctlin@mail.nctu.edu.tw
Jie Lu, University of Technology, Sydney, Australia
e-mail: Jie.Lu@uts.edu.au
Patricia Melin, Tijuana Institute of Technology, Tijuana, Mexico
e-mail: epmelin@hafsamx.org
Nadia Nedjah, State University of Rio de Janeiro, Rio de Janeiro, Brazil
e-mail: nadia@eng.uerj.br
Ngoc Thanh Nguyen, Wroclaw University of Technology, Wroclaw, Poland
e-mail: Ngoc-Thanh.Nguyen@pwr.edu.pl
Jun Wang, The Chinese University of Hong Kong, Shatin, Hong Kong
e-mail: jwang@mae.cuhk.edu.hk

More information about this series at http://www.springer.com/series/11156
Advances in Signal Processing and Intelligent Recognition Systems

Preface

This Edited Volume contains a selection of refereed and revised papers originally presented at the second International Symposium on Signal Processing and Intelligent Recognition Systems (SIRS-2015), December 16–19, 2015, Trivandrum, India. SIRS-2015 provided a forum for the sharing, exchange, presentation and discussion of original research results in both methodological issues and different application areas of signal processing and pattern recognition.

Credit for the quality of the symposium proceedings goes first and foremost to the authors. They contributed a great deal of effort and creativity to produce this work, and we are very thankful that they chose SIRS-2015 as the place to present it. All the authors who submitted papers, both accepted and rejected, are responsible for keeping the SIRS program vital. The program committee received 175 submissions. The committee had a very challenging task of choosing high quality submissions. Each paper was peer reviewed by at least three or more independent referees and the papers were selected based on the referee recommendations. The technical program of SIRS’15 comprises of 59 papers (41 regular papers and 18 short papers). This volume is organized into different topical sections. The papers offer stimulating insights into biometrics, digital watermarking, recognition systems, image and video processing, signal and speech processing, pattern recognition, machine learning and knowledge-based systems. Two workshops were co-located with the symposium: workshop on Advances in Image Processing, Computer Vision, and Pattern Recognition (IWICP-2015) and workshop on Signal Processing for Wireless and Multimedia Communications (SPWMC’15).

The success of such an event is mainly due to the hard work and dedication of a number of people and the collaboration of several institutions. We are grateful to the members of the program committee for reviewing and selecting papers in a very short period of time. Many thanks to all the Chairs and their involvement and support have added greatly to the quality of the symposium. We also wish to thank all the members of the Advisory Committee, whose work and commitment were invaluable. We would like to express our sincere gratitude to local organizing committees that has made this event a success. Our special thanks also to the
keynote speakers and tutorial presenters for their effort in preparing the lectures. The EDAS conference system proved very helpful during the submission, review, and editing phases.

We wish to express our sincere thanks to Thomas Ditzinger, Senior Editor, Engineering/AppliedSciences Springer-Verlag and Janusz Kacprzyk, Series Editor for their help and cooperation.

Finally, we hope that you will find this edited book to be a valuable resource in your professional, research, and educational activities whether you are a student, academic, researcher, or a practicing professional.

Sabu M. Thampi
Sanghamitra Bandyopadhyay
Sri Krishnan
Kuan-Ching Li
Sergey Mosin
Maode Ma
Organization
Organized by

Indian Institute of Information Technology and Management-Kerala
(IIITM-K), Trivandrum, India
http://www.iiitmk.ac.in

in association with
Committee

Advisory Committee

Janusz Kacprzyk Warsaw University of Technology, Poland
Hideyuki Takagi Kyushu University, Japan
Oge Marques Florida Atlantic University (FAU) (Boca Raton, Florida), USA
Sankar Kumar Pal Indian Statistical Institute, Kolkata, India
Sugata Sanyal Tata Institute of Fundamental Research, India
Alexander Gelbukh Instituto Politecnico Nacional, Mexico
Dharma P. Agrawal University of Cincinnati, USA
Pramod K. Varshney Syracuse University, USA
Sushmita Mitra Indian Statistical Institute, Kolkata, India
Selwyn Piramuthu University of Florida, USA
Mario Koeppen Kyushu Institute of Technology, Japan
Suash Deb INNS India Regional Chapter
Nallanathan King’s College London, United Kingdom
Arumugam
Sri Krishnan Ryerson University, Toronto, Canada
Salah Bourrnane Ecole Centrale Marseille, France
P. Nagabhushan University of Mysore, India
Rajasree M.S Director, IIITM-K, India
Elizabeth Sherly IIITM-K, India

General Chair

Sanghamitra Bandyopadhyay Indian Statistical Institute, Kolkata, India

Organising Chair

Sabu M. Thampi IIITM-K, India

Program Chairs

Kuan-Ching Li Providence University, Taiwan
Sergey Mosin Vladimir State University, Russia
Maode Ma Nanyang Technological University, Singapore
TPC Members/Additional Reviewers

Cesar Cardenas  
Tecnologico de Monterrey - Campus Queretaro, Mexico

Marcelo Carvalho  
University of Brasilia, Brazil

El-Sayed El-Alfy  
King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia

Rodolfo Oliveira  
Nova University of Lisbon, Portugal

Aniruddha Bhattacharjya  
Guru Nanak Institute of Technology (GNIT), India

Mohammed Khan  
Indian Institute of Technology, Hyderabad, India

Ryszard Tadeusiewicz  
AGH University of Science and Technology, Poland

Maaruf Ali  
University of East London, United Kingdom

Biju Issac  
Teesside University, Middlesbrough, United Kingdom

Felix Albu  
Valahia University of Targoviste, Romania

Mihaela Albu  
Politehnica University of Bucharest, Romania

Anna Antonyová  
University of Prešov in Prešov, Slovakia

Tarek Bejaoui  
University of Paris-Sud 11, France

Vikrant Bhateja  
Shri Ramswaroop Memorial Group of Colleges, India

Igor Bisio  
University of Genoa, Italy

Tufik Buzid  
Algabel Algharbi University, Tripoli, Libya

Chinmay Chakraborty  
Birla Institute of Technology, Mesra, India

Zhe Chen  
Northeastern University, P.R. China

Wei-Yu Chiu  
Yuan Ze University, Taiwan

Sung-Bae Cho  
Yonsei University, Korea

Ashutosh Dubey  
Trinity Institute of Technology and Research, Bhopal, India

Mourad Fakhfakh  
University of Sfax, Tunisia

Ponnambalam G  
Monash University Sunway Campus, Malaysia

Manish Gupta  
Hindustan Institute of Technology and Management, Agra, India

Saad Harous  
UAE University, UAE

Sarangapani Jagannathan  
Missouri University of Science and Technology, USA

Raveendranathan  
LBS Institute of Technology for Women, Poojappura, India

Kalathil Chellappan  
National Institute of Technology, Silchar, India

Abhishek Midya  
Osaka Prefecture University, Japan

Yusuke Nojima  
Politehnica University of Timisoara, Romania

Radu-Emil Precup  
Templecity Institute of Technology and Engineering, USA

Priya Ranjan
Ramesh Rayudu  Victoria University of Wellington, New Zealand
Shubhajit Roy  School of Computing and Electrical Engineering, IIT Mandi, India
Ravi Subban  Pondicherry University, Pondicherry, India
Daisuke Umehara  Kyoto Institute of Technology, Japan
Gancho Vachkov  The University of the South Pacific (USP), Fiji
Jaap van de Beek  Luleå University of Technology, Sweden
Fanggang Wang  Beijing Jiaotong University, P.R. China
Boyang Zhou  State Grid Corporation of China, P.R. China
Brian Sadler  Army Research Laboratory, USA
Batu Krishna Chalise  Arraycomm, USA
Liau Eric  Intel Corporation, Germany
Sunil Kumar Kopparapu  Tata Consultancy Services, India
Erwin Daculan  University of San Carlos, Philippines
Pitoyo Hartono  Chuky University, Japan
Wei-Chiang Hong  Oriental Institute of Technology, Taiwan
Radu Vasiu  Politehnica University of Timisoara, Romania
Paolo Crippa  Universita Politecnica delle Marche, Italy
Kuan-Chieh Huang  National Cheng Kung University, Taiwan
Sergey Mosin  Vladimir State University, Russia
Mohammadali  Shahrekord University, Iran
Mahfuzah Mustafa  Universiti Malaysia Pahang, Malaysia
Teddy Gunawan  International Islamic University Malaysia, Malaysia
Nor Hayati Saad  UiTM, Malaysia
Anas Abou El Kalam  UCA - ENSA/OSCARS Laboratory, Morocco
Siby Abraham  University of Mumbai, India
Amit Acharyya  IIT HYDERABAD, India
Ali Al-Sherbaz  The University of Northampton, United Kingdom
Angeliki Alexiou  University of Piraeus, Greece
Belal Amro  Hebron University, Palestine
Markos Anastasopoulos  University of Bristol, United Kingdom
Manjunath Aradhya  Sri Jayachamarajendra College of Engineering, India
Ognjen Arandjelovic  University of St Andrews, United Kingdom
Krishna Asawa  Jaypee Institute of Information Technology, India
Ouarda Assas  Universite of Msila, Algeria
Vahida Attar  College of Engineering Pune, India
Vinayak Bairagi  University of Pune, India
Valentina Balas  Aurel Vlaicu University of Arad, Romania
Faycal Bensaali  Qatar University, Qatar
Zoran Bojkovic  University of Belgrade, Serbia
Ivo Bukovsky  Czech Technical University in Prague, Czech Republic
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joao Paulo Carvalho</td>
<td>Instituto Superior Tecnico - Technical University of Lisbon, Portugal</td>
</tr>
<tr>
<td>Mehmet Celenk</td>
<td>Ohio University, USA</td>
</tr>
<tr>
<td>Nabendu Chaki</td>
<td>University of Calcutta, India</td>
</tr>
<tr>
<td>Jayasree Chakraborty</td>
<td>Memorial Sloan Kettering Cancer Center, USA</td>
</tr>
<tr>
<td>Anjali Chandavale</td>
<td>University of Pune, India</td>
</tr>
<tr>
<td>Rama Seshagiri Rao</td>
<td>JNTU Hyderabad, India</td>
</tr>
<tr>
<td>Channapragada</td>
<td></td>
</tr>
<tr>
<td>Amitava Chatterjee</td>
<td>Jadavpur University, India</td>
</tr>
<tr>
<td>Ouyang Chen-Sen</td>
<td>I-Shou University, Taiwan</td>
</tr>
<tr>
<td>Yordan Chervenkov</td>
<td>Naval Academy - Varna, Bulgaria</td>
</tr>
<tr>
<td>Silvana Costa</td>
<td>Instituto Federal de Educacao, Ciencia e Tecnologia da Paraiba, Brazil</td>
</tr>
<tr>
<td>Pasquale Daponte</td>
<td>University of Sannio, Italy</td>
</tr>
<tr>
<td>Ashok Kumar Das</td>
<td>International Institute of Information Technology, Hyderabad, India</td>
</tr>
<tr>
<td>Kenneth Dawson-Howe</td>
<td>Trinity College Dublin, Ireland</td>
</tr>
<tr>
<td>Tiago de Carvalho</td>
<td>Federal Rural University of Pernambuco, Brazil</td>
</tr>
<tr>
<td>Grzegorz Deita</td>
<td>Wroclaw University of Technology, Poland</td>
</tr>
<tr>
<td>Vani Devi</td>
<td>IIST, India</td>
</tr>
<tr>
<td>Moussa Dif</td>
<td>Universite Mouloud Mammri, Algeria</td>
</tr>
<tr>
<td>Ibrahim El rube’</td>
<td>Taif University, Saudi Arabia</td>
</tr>
<tr>
<td>Vaibhav Gandhi</td>
<td>Middlesex University, United Kingdom</td>
</tr>
<tr>
<td>Rama Garimella</td>
<td>IIIT Hyderabad, India</td>
</tr>
<tr>
<td>Nithin George</td>
<td>IIT Gandhinagar, India</td>
</tr>
<tr>
<td>Sudhanshu Gonce</td>
<td>University of Pune, India</td>
</tr>
<tr>
<td>Steven Guan</td>
<td>Xian Jiatong-Liverpool University, Australia</td>
</tr>
<tr>
<td>Xiaoning Guo</td>
<td>Multimedia University, Malaysia</td>
</tr>
<tr>
<td>Maki Habib</td>
<td>The American University in Cairo, Egypt</td>
</tr>
<tr>
<td>Bo Han</td>
<td>Aalborg University, Denmark</td>
</tr>
<tr>
<td>Thomas Hanne</td>
<td>University of Applied Sciences, Switzerland</td>
</tr>
<tr>
<td>Yong Hu</td>
<td>The University of Hong Kong, Hong Kong</td>
</tr>
<tr>
<td>Hirotaka Inoue</td>
<td>National Institute of Technology, Kure College, Japan</td>
</tr>
<tr>
<td>Marina Ivasic-Kos</td>
<td>University of Rijeka, Croatia</td>
</tr>
<tr>
<td>Frank Klawonn</td>
<td>Ostfalia University, Germany</td>
</tr>
<tr>
<td>Mario Köppen</td>
<td>Kyushu Institute of Technology, Japan</td>
</tr>
<tr>
<td>Andrey Krylov</td>
<td>Lomonosov Moscow State University, Russia</td>
</tr>
<tr>
<td>Ajey Kumar</td>
<td>Symbiosis Centre for Information Technology, India</td>
</tr>
<tr>
<td>Zsofia Lendek</td>
<td>Technical University of Cluj-Napoca, Romania</td>
</tr>
<tr>
<td>Edwin Lughofer</td>
<td>University of Linz, Austria</td>
</tr>
<tr>
<td>Jayamohan M</td>
<td>College of Applied Science, India</td>
</tr>
<tr>
<td>George Magoulas</td>
<td>Birkbeck College, University of London, United Kingdom</td>
</tr>
</tbody>
</table>
Noor Mahammad Sk  
M Manikandan  
Sapan Mankad  
Joycee Mekie  
Varun Menon  
Deepak Mishra  
Marek Miskowicz  
Lahcène Mitiche  
Ravibabu Mulavesala  
Sakthi Muthiah  
Jyothihasa Nair  
Ibrahim Nasir  
Nizampatnam Neelima  
Kalman Palagyi  
Rosaura Palma-Orozco  
Hemprasad Patil  
Isabella Poggi  
Rahul Pol  
M.V.N.K. Prasad  
Padma Prasada  
V.B. Surya Prasath  
Hugo Proença  
Grienggrai Rajchakit  
Ranjana Rajnish  
Alexandre Ramos  
Ajita Rattani  
Carlos Regis  
Asharaf S  
Sachin Kumar S  
Sumitra S  
Beatriz Sainz  
Ajit Samasgikar  
Andrews Samraj  
Luciano Sanchez  
Valerio Scordamaglia  
Kandasamy Selvaradjou  
Kaushal Shukla  
Patrick Siarry  
Vladimir Spitsyn  
Mu-Chun Su  
Gorthi Subrahmanyam

IIITDM Kancheepuram, India  
Anna University, India  
Nirma University, Ahmedabad, India  
IIT Gandhinagar, India  
S C M S School of Engineering and Technology, India  
IIST, India  
AGH University of Science and Technology, Poland  
University of Djelfa, Algeria  
Indian Institute of Technology Ropar, India  
LNMIIT, India  
Amrita University, India  
Sebha University, Libya  
Engineering, India  
University of Pretoria, South Africa  
University of Szeged, Hungary  
Instituto Politecnico Nacional, Mexico  
Visvesvaraya National Institute of Technology, India  
Roma Tre University, Italy  
Pune University, India  
IDRBT, India  
VTU Belgaum, India  
University of Missouri-Columbia, USA  
University of Beira Interior, Portugal  
Maejo University, Thailand  
Amity University, Lucknow, India  
Federal University of Itajubá, Brazil  
Michigan State University, USA  
IFPB, Brazil  
IIITMK, Trivandrum, India  
Amrita Vishwa Vidyapeetham, India  
IIST, India  
University of Valladolid, Spain  
VTU Belgaum, India  
Mahendra Engineering College, India  
University of Oviedo, Spain  
University of Reggio Calabria, Italy  
Pondicherry Engineering College, India  
Indian Institute of Technology, India  
University of Paris XII, France  
Tomsk Polytechnic University, Russia  
National Central University, Taiwan  
IIST, India
Roberto Tagliaferri University of Salerno, Italy
Rohit Thanki C U Shah University, India
Ciza Thomas College of Engineering Trivandrum, India
Shikha Tripathi Amrita Vishwa Vidhyapeetham, India
Ralph Turner Eastern Kentucky University, USA
Jayaraman Valarmathi Vellore Institute of Technology, India
Zita Vale Polytechnic Institute of Porto, Portugal
Michael Vrahatis University of Patras, Greece
Haixin Wang Fort Valley State University, USA
Rolf Wurtz Ruhr-University of Bochum, Germany
Ales Zamuda University of Maribor, Slovenia
Hector Zenil Oxford University and Karolinska Institute, United Kingdom
Ming-Yue Zhai North China Electric Power University, P.R. China
Shang-Ming Zhou Swansea University, United Kingdom
Reyer Zwiggelaar Aberystwyth University, United Kingdom
Arun Gopalakrishnan Centre for Development of Advanced Computing, India
V Satheesh Prabhu Cdac, India
Sreeraman Rajan Defence Research and Development Canada-Ottawa, Canada
Sheeba Rani IIST Trivandrum, India
Anustup Choudhury Sharp Laboratories of America, USA
Julius Eiweck Alcatel-Lucent Austria, Austria
Chi-Keong Goh Rolls-Royce Advanced Technology Centre, Singapore
Rajeev Kumaraswamy QuEST Global Engineering Services Pvt Ltd, India
Kumar Padmanabh Robert Bosch, India
Andrei Shin Samsung SDS Co., Ltd., Korea
Gustavo Fernández Domínguez AIT Austrian Institute of Technology, Austria
Kwasi Opare MobileLink LAB, University of Electronic Science and Technology, P.R. China
# TPC Members/Additional Reviewers

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ayan Mondal</td>
<td>Indian Institute of Technology, Kharagpur, India</td>
</tr>
<tr>
<td>Biju Issac</td>
<td>Teesside University, Middlesbrough, United Kingdom</td>
</tr>
<tr>
<td>Mohammad Faiz Liew</td>
<td>Universiti Tun Hussein Onn Malaysia (UTHM), Malaysia</td>
</tr>
<tr>
<td>Abdullah</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Anna Antonyová</td>
<td>University of Prešov in Prešov, Slovakia</td>
</tr>
<tr>
<td>Tarek Bejaoui</td>
<td>University of Paris-Sud 11, France</td>
</tr>
<tr>
<td>Ravi Subban</td>
<td>Pondicherry University, Pondicherry, India</td>
</tr>
<tr>
<td>Geert Verdoolaege</td>
<td>Ghent University, Belgium</td>
</tr>
<tr>
<td>Adib Chowdhury</td>
<td>University College of Technology Sarawak, Malaysia</td>
</tr>
<tr>
<td>Naveen Kolla</td>
<td>Geethanjali Institute of Science and Technology Nellore, India</td>
</tr>
<tr>
<td>Honglei Zhang</td>
<td>Tampere University of Technology, Finland</td>
</tr>
<tr>
<td>Moulay Akhloufi</td>
<td>Laval University, Canada</td>
</tr>
<tr>
<td>Vikrant Bhatija</td>
<td>Shri Ramswaroop Memorial Group of Professional Colleges, Lucknow (UP), India</td>
</tr>
<tr>
<td>Sung-Bae Cho</td>
<td>Yonsei University, Korea</td>
</tr>
<tr>
<td>Bijoy Ghosh</td>
<td>Texas Tech University, USA</td>
</tr>
<tr>
<td>Manish Gupta</td>
<td>Hindustan Institute of Technology and Management, Agra, India</td>
</tr>
<tr>
<td>Sunil Kumar Kopparapu</td>
<td>Tata Consultancy Services, India</td>
</tr>
<tr>
<td>Srimanta Mandal</td>
<td>Indian Institute of Technology Mandi, India</td>
</tr>
<tr>
<td>Badri Narayan Subudhi</td>
<td>Indian Statistical Institute, Kolkata, India</td>
</tr>
<tr>
<td>Davide Valeriani</td>
<td>University of Essex, United Kingdom</td>
</tr>
<tr>
<td>Abdul Halim Ali</td>
<td>Universiti Kuala Lumpur - International College, Malaysia</td>
</tr>
<tr>
<td>Burhan Gulbahar</td>
<td>Ozyegin University, Turkey</td>
</tr>
<tr>
<td>Thanikaiselvan V</td>
<td>VIT University, India</td>
</tr>
<tr>
<td>Paolo Crippa</td>
<td>Università Politecnica delle Marche, Italy</td>
</tr>
<tr>
<td>Kuan-Chieh Huang</td>
<td>National Cheng Kung University, Taiwan</td>
</tr>
<tr>
<td>Amita Kapoor</td>
<td>Shaheed Rajguru College of Applied Sciences for Women, India</td>
</tr>
<tr>
<td>Rakesh Manjappa</td>
<td>Indian Institute of Science, India</td>
</tr>
<tr>
<td>Ankit Chaudhary</td>
<td>Truman State University, USA</td>
</tr>
<tr>
<td>Prasant Sahu</td>
<td>IIT Bhubaneswar, India</td>
</tr>
<tr>
<td>Shikha Agrawal</td>
<td>Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal, India</td>
</tr>
</tbody>
</table>
Manjunath Aradhya  Sri Jayachamarajendra College of Engineering, India
Sreeparna Banerjee  West Bengal University of Technology, India
Krishna Battula  Jawaharlal Nehru Technological University Kakinada, India
Evgeny Belyaev  University of Oulu, Finland
Philip Branch  Swinburne University of Technology, Australia
Prabhakar C j  Kuvempu University, India
Azza Elaskary  Atomic Energy Authority, Egypt
Omar Farooq  Aligarh Muslim University, Aligarh, India
Gianluigi Ferrari  University of Parma, Italy
Hareesha  Manipal University, India
M. Udin Harun Al Rasyid  Politeknik Elektronika Negeri Surabaya (PENS) - Indonesia, Indonesia
Katerina Kabassi  TEI of the Ionian Islands, Greece
Maurice Khabbaz  Notre-Dame University, Lebanon
Yassine Khlifi  Umm Al-Qura University, KSA, Saudi Arabia
Sreeraj M  Cochin University of Science and Technology, India
Marek Miskowicz  AGH University of Science and Technology, Poland
Júlio Nievola  Pontificia Universidade Catolica do Parana – PUCPR, Brazil
Subhendu Pani  BPUT, India
Francesco Paolucci  Scuola Superiore Sant’Anna, Italy
M.V.N.K. Prasad  IDRBT, India
Kandarpa Sarma  Gauhati University, India
Sheikh Mohammed  Center for Control of Chronic Diseases (CCCD), Bangladesh
Shariful Islam  Dayalbagh Educational Institute, India
Muthukumar  National Institute of Technology, Puducherry, India
Subramaniam  Amrita School of Engineering, India
Shikha Tripathi  Amrita School of Engineering, Amrita Vishwa Vidhyapeetham, India
Vani Vasudevan  Al Yamamah University, Saudi Arabia
Ujjwal Verma  Manipal University, India
Qiang Yang  Zhejiang University, P.R. China
Nuri Yilmazer  Texas A&M University-Kingsville, USA
Musheer Ahmad  Jamia Millia Islamia, New Delhi, India
Fayas Asharindavida  Taif University, Saudi Arabia
Bhaskar Belavadi  BGS Health & Education city, Uttarahalli Road, Bangalore, India
P. Pablo Garrido Abenza  Miguel Hernandez University, Spain
Rahul Gupta
Raza Hasan
Thiang Hwang Liong Hoat
Pavan Kumar C
Anan Liu
Changqing Luo
K Mahantesh
Ibrahim Missaoui
Carlos Oliveira
Prakornchai Phonrattanasak
Rajiv Singh
Kapil Wankhade
Akash Yadav
Suja P.
Vimina R
Siriporn Dachasilaruk
Amrita A Manjrekar
Afaf Merazi
Sabri Abdelouahed
Anna Bartkowiak
Salah Bourennane
Deepak Choudhary
Simon Fong
Steven Guan
Alex James
Agilandeeswari Loganathan
Pascal Lorenz
Rosaura Palma-Orozco
Grienggrai Rajchakit
Abdelmadjid Reciou
Patrick Siarry
Georgios Sirakoulis
Elpida Tzafestas
Michael Vrahatis
Reyer Zwiggelaar
G Deka
Shuaib Ahmed
Julius Eiweck

Manipal Institute of Technology, India
Middle East College, Oman
Petra Christian University, Indonesia
VIT University, India
Tianjin University, P.R. China
Mississippi State University, USA
SJBIT, India
National Engineering School of Tunis, Tunisia
IFRJ, Brazil
North Eastern University, Thailand
Banasthali University, India
G.H. Raisoni College of Engineering Nagpur, INDIA, India
Indian Institute of Technology, Patna, India
Amrita School of Engineering, Amrita Vishwa Vidyapeetham, India
Rajagiri College of Social Sciences, India
Naresuan University, Thailand
Shivaji University, India
Djillali Liabès University of Sidi Bel-Abbès, Algeria
Faculty of Science Dhar el Mahraz Fes, Morocco
University of Wroclaw, Poland
Ecole Centrale Marseille, France
LPU, India
University of Macau, Macao
Xian Jiatong-Liverpool University, Australia
Nazarbayev University, Kazakhstan
VIT University, India
University of Haute Alsace, France
Instituto Politécnico Nacional, Mexico
Maejo University, Thailand
University of Boumerdes, Algeria
University of Paris XII, France
Democritus University of Thrace, Greece
University of Athens, Greece
University of Patras, Greece
Aberystwyth University, United Kingdom
Directorate General of Training, India
Tata Research Development and Design Center, India
Alcatel-Lucent Austria, Austria
Workshop on Signal Processing for Wireless and Multimedia Communications (SPWMC’15)

TPC Members/Additional Reviewers

Kamran Arshad  University of Greenwich, United Kingdom  
Antoine Bagula  University of the Western Cape, South Africa  
Ramiro Barbosa  Institute of Engineering of Porto, Portugal  
Bao Rong Chang  National University of Kaohsiung, Taiwan  
Phan Cong-Vinh  NTT University, Vietnam
Floriano De Rango  
University of Calabria, Italy
Salvatore Distefano  
Politecnico di Milano, Italy
El-Sayed El-Alfy  
King Fahd University of Petroleum and Minerals (KFUPM), Saudi Arabia
Mohamed El-Tarhuni  
American University of Sharjah, UAE
Steven Guan  
Xian Jiatong-Liverpool University, Australia
Vana Kalogeraki  
Athens University of Economics and Business, Greece
George Karagiannidis  
Aristotle University of Thessaloniki, Greece
Chandan Karmakar  
The University of Melbourne, Australia
Pascal Lorenz  
University of Haute Alsace, France
Júlio Nievola  
Pontificia Universidade Catolica do Paraná – PUCPR, Brazil
Madan Pande  
International Institute of Information Technology - Bangalore, India
Sherif Rashad  
Florida Polytechnic University, USA
Antonio Ruiz-Martínez  
University of Murcia, Spain
Jorge Sá Silva  
University of Coimbra, Portugal
Maytham Safar  
Kuwait University, Kuwait
Luciano Sanchez  
University of Oviedo, Spain
Björn Schuller  
Imperial College London, United Kingdom
Patrick Siarry  
University of Paris XII, France
Toshio Tsuji  
Hiroshima University, Japan
Elpida Tzafestas  
University of Athens, Greece
Athanasios Vasilakos  
National Technical University of Athens, Greece
Vasilakos Vrahatis  
University of Patras, Greece
Reyer Zwiggelaar  
Aberystwyth University, United Kingdom
Ravi Kodali  
National Institute of Technology, Warangal, India
E Hari Krishna  
KU College of Engineering & Technology, India
Navin Kumar  
Amrita University, India
Dnyanesh Mantri  
Pune University, India
Pratima Patel  
Autonomous, India
Vasanthi S  
SRM University, India
Giridhar Mandyam  
Qualcomm, USA
Kyriakos Manousakis  
Applied Communication Sciences, USA
Stephane Senecal  
Orange Labs, France
Pawan Bhandari  
Intel, India
Eugénia Bernardino  
Polytechnic Institute of Leiria, Portugal
Contents

Biometrics/Digital Watermarking/Recognition Systems

Emotion Recognition from Facial Expressions for 4D Videos Using Geometric Approach .......................................................... 3
V.P. Kalyan Kumar, P. Suja and Shikha Tripathi

Fraudulent Image Recognition Using Stable Inherent Feature .... 15
Deny Williams, G. Krishnalal and V.P. Jagathy Raj

Kernel Visual Keyword Description for Object and Place Recognition . 27
Abbas M. Ali and Tarik A. Rashid

Hardware Accelerator for Facial Expression Classification Using Linear SVM ................................................................. 39
Sumeet Saurav, Sanjay Singh, Ravi Saini and Anil K. Saini

Enhancing Face Recognition Under Unconstrained Background Clutter Using Color Based Segmentation ......................... 51
Ankush Chatterjee, Deepak Mishra and Sai Subrahmanyam Gorthi

Emotion Recognition from 3D Images with Non-Frontal View Using Geometric Approach .............................................. 63
D. KrishnaSri, P. Suja and Shikha Tripathi

Real-Time Automatic Camera Sabotage Detection for Surveillance Systems ................................................................. 75
K. Sitara and B.M. Mehtre

An Improved Approach to Crowd Event Detection by Reducing Data Dimensions ................................................... 85
Aravinda S. Rao, Jayavardhana Gubbi and Marimuthu Palaniswami
Art of Misdirection Using AES, Bi-layer Steganography and Novel King-Knight’s Tour Algorithm ........................................ 97
Sudharshan Chakravarthy, Vishnu Sharon, Karthikeyan Balasubramanian and V. Vaithiyanathan

Digital Watermarking Using Fractal Coding ............................. 109
Rama Seshagiri Rao Channapragada and Munaga V.N.K. Prasad

A Cheque Watermarking System Using Singular Value Decomposition for Copyright Protection of Cheque Images .................. 119
Sudhanshu Suhas Gonge and Ashok Ghatol

Biometric Watermarking Technique Based on CS Theory and Fast Discrete Curvelet Transform for Face and Fingerprint Protection .... 133
Rohit Thanki and Komal Borisagar

Cancelable Fingerprint Cryptosystem Based on Convolution Coding .. 145
Mulagala Sandhya and Munaga V.N.K. Prasad

A Bio-cryptosystem for Fingerprints Using Delaunay Neighbor Structures(DNS) and Fuzzy Commitment Scheme ......................... 159
Mulagala Sandhya and Munaga V.N.K. Prasad

Image/ Video Processing

Improving the Feature Stability and Classification Performance of Bimodal Brain and Heart Biometrics ........................................ 175
Ramaswamy Palaniappan, Samraj Andrews, Ian P. Sillitoe, Tarsem Shira and Raveendran Paramesran

Denoising Multi-coil Magnetic Resonance Imaging Using Nonlocal Means on Extended LMMSE ......................................... 187
V. Soumya, Abraham Varghese, T. Manesh and K.N. Neetha

An Intelligent Blind Semi-fragile Watermarking Scheme for Effective Authentication and Tamper Detection of Digital Images Using Curvelet Transforms ........................................ 199
K.R. Chetan and S. Nirmala

Dental Image Retrieval Using Fused Local Binary Pattern & Scale Invariant Feature Transform ........................................ 215
R. Suganya, S. Rajaram, S. Vishalini, R. Meena and T. Senthil Kumar

Block Based Variable Step Size LMS Adaptive Algorithm for Reducing Artifacts in the Telecardiology System ......................... 225
Thumbur Gowri and P. Rajesh Kumar

Braille Tutor: A Gift for the Blind ........................................ 237
Anjana Joshi and Ajit Samasgikar
Performance Evaluation of S-Golay and MA Filter on the Basis of White and Flicker Noise ........................................ 245
Shivang Baijal, Shelvi Singh, Asha Rani and Shivangi Agarwal

An Efficient Multi Object Image Retrieval System Using Multiple Features and SVM .............................................. 257
Nizampatnam Neelima and E. Sreenivasa Reddy

Blood Cells Counting by Dynamic Area-Averaging Using Morphological Operations to SEM Images of Cancerous Blood Cells ... 267
Kanik Palodhi, Dhrubajyoti Dawn and Amiya Halder

Texture Guided Active Contour for Object Segmentation in Natural Images .......................................................... 273
Glaxy George and M. Sreeraj

Development of Tomographic Imaging Algorithms for Sonar and Radar ................................................................. 285
Ashish Roy, Supriya Chakraborty and Chinmoy Bhattacharya

Signal/Speech Processing

Design and Development of an Innovative Biomedical Engineering Application Toolkit (B.E.A.T. ®) for m-Health Applications ........ 299
Abhinav, Avval Gupta, Shona Saseendran, Abhijith Bailur, Rajnish Juneja and Balram Bhargava

A VMD Based Approach for Speech Enhancement ......................... 309
B. Ganga Gowri, S. Sachin Kumar, Neethu Mohan and K.P. Soman

Opportunistic Routing with Virtual Coordinates to Handle Communication Voids in Mobile Ad hoc Networks .................. 323
Varun G. Menon and P.M. Joe Prathap

Acoustic Echo Cancellation Technique for VoIP .......................... 335
Balasubramanian Nathan, Yung-Wey Chong and Sabri M. Hansi

MRAC for a Launch Vehicle Actuation System ............................. 345
Elizabath Rajan, Baby Sebastian and M.M. Shinu

Analysis of Inspiratory Muscle of Respiration in COPD Patients ...... 357
Archana B. Kanwade and Vinayak Bairagi

Interconversion of Emotions in Speech Using TD-PSOLA ............... 367
B. Akanksh, Susmitha Vekkot and Shikha Tripathi
Pattern Recognition/Machine Learning/Knowledge-Based Systems

A Technique of Analog Circuits Testing and Diagnosis Based on Neuromorphic Classifier ........................................ 381
Sergey Mosin

A Genetic PSO Algorithm with QoS-Aware Cluster Cloud Service Composition ............................................. 395
Mohammed Nisar Faruk, G. Lakshmi Vara Prasad and Govind Divya

Anomalous Crowd Event Analysis Using Isometric Mapping ........ 407
Aravinda S. Rao, Jayavardhana Gubbi and Marimuthu Palaniswami

Access Control System Which Uses Human Behavioral Profiling for Authentication ........................................... 419
Lohit Penubaku, Jong-Hoon Kim, Sitharama S. Iyengar and Kadbur A. Shilpa

Mathematical Morphology and Region Clustering Based Text Information Extraction from Malayalam News Videos ............. 431
K. Anoop, Manjary P. Gangan and V.L. Lajish

The Impacts of ICT Support on Information Distribution, Task Assignment for Gaining Teams’ Situational Awareness in Search and Rescue Operations .................................................. 443
Vimala Nunavath, Jaziar Radianti, Tina Comes and Andreas Prinz

A Hybrid Approach to Rainfall Classification and Prediction for Crop Sustainability ............................................... 457
Prajwal Rao, Ritvik Sachdev and Tribikram Pradhan

Development and Evaluation of Automated Algorithm for Estimation of Winds from Wind Profiler Spectra ......................... 473
E. Ramyakrishna, T. Narayana Rao and N. Padmaja

A Real Time Patient Monitoring System for Heart Disease Prediction Using Random Forest Algorithm ......................... 485
S. Sreejith, S. Rahul and R.C. Jisha

Phoneme Selection Rules for Marathi Text to Speech Synthesis with Anuswar Places ................................................. 501
Manjare Chandraprabha Anil and S. D. Shirbahadurkar

Solving Multi Label Problems with Clustering and Nearest Neighbor by Consideration of Labels ........................................ 511
C.P. Prathibhamol and Asha Ashok
# Contents

**Multi-view Robotic Time Series Data Clustering and Analysis Using Data Mining Techniques** .................................................. 521
M. Reshma, Priyanka C. Nair, Radhakrishnan Gopalapillai, Deepa Gupta and TSB Sudarshan

**Twofold Detection of Multilingual Documents Using Local Features** . . . 533
Glaxy George and M. Sreeraj

**Workshop on Advances in Image Processing, Computer Vision, and Pattern Recognition (IWICP-2015)**

**On Paper Digital Signature (OPDS)** ........................................ 547
Sajan Ambadiyil, V.B. Vibhath and V.P. Mahadevan Pillai

**Scale Invariant Detection of Copy-Move Forgery Using Fractal Dimension and Singular Values** ........................................... 559
Rani Susan Oommen, M. Jayamohan and S. Sruthy

**Adaptive Nonlocal Filtering for Brain MRI Restoration** ............ 571
V.B. Surya Prasath and P. Kalavathi

**Automatic Leaf Vein Feature Extraction for First Degree Veins** .... 581
S. Sibi Chakkaravarthy, G. Sajeevan, E. Kamalanaban and K.A. Varun Kumar

**Singular Value Decomposition Based Image Steganography Using Integer Wavelet Transform** ........................................... 593
Siddharth Singh, Rajiv Singh and Tanveer J. Siddiqui

**Unsupervised Learning Based Video Surveillance System Established with Networked Cameras** ........................................ 603
R. Venkatesan, P. Dinesh Anton Raja and A. Balaji Ganesh

**Automatic Left Ventricle Segmentation in Cardiac MRI Images Using a Membership Clustering and Heuristic Region-Based Pixel Classification Approach** ........................................ 615
Vinayak Ray and Ayush Goyal

**Mixed Noise Removal Using Hybrid Fourth Order Mean Curvature Motion** .............................................................. 625
V.B. Surya Prasath and P. Kalavathi

**An Implicit Segmentation Approach for Telugu Text Recognition Based on Hidden Markov Models** .................................. 633
D. Koteswara Rao and Atul Negi

**Detection of Copy-Move Forgery in Images Using Segmentation and SURF** .............................................................. 645
V.T. Manu and B.M. Mehtre
Automatic Pattern Recognition for Detection of Disease from Blood Drop Stain Obtained with Microfluidic Device ................. 655
Basant S. Sikarwar, Mukesh Roy, Priya Ranjan and Ayush Goyal

Workshop on Signal Processing for Wireless and Multimedia Communications (SPWMC’15)

STAMBA: Security Testing for Android Mobile Banking Apps .......... 671
Sriramulu Bojjagani and V.N. Sastry

An Efficient and Secure RSA Based Certificateless Signature Scheme for Wireless Sensor Networks .......................... 685
Jitendra Singh, Vimal Kumar and Rakesh Kumar

SeaMoX: A Seamless Mobility Management Scheme for Real-Time Multimedia Traffic Over Cellular Networks ............... 699
D. Kumaresh, N. Suhas, S. Garge Gopi Krishna, S.V.R. Anand and Malati Hegde

Author Index ........................................................................ 711
Part I
Biometrics/Digital
Watermarking/Recognition Systems
Emotion Recognition from Facial Expressions for 4D Videos Using Geometric Approach

V.P. Kalyan Kumar, P. Suja and Shikha Tripathi

Abstract Emotions are important to understand human behavior. Several modalities of emotion recognition are text, speech, facial expression or gesture. Emotion recognition through facial expressions from video play a vital role in human computer interaction where the facial feature movements that convey the emotion expressed need to be recognized quickly. In this work, we propose a novel method for the recognition of six basic emotions in 4D video sequences of BU-4DFE database using geometric based approach. We have selected key facial points out of the 83 feature points provided in the BU-4DFE database. A video expressing emotion has frames containing neutral, onset, apex and offset of that emotion. We have identified the apex frame from a video sequence automatically. The Euclidean distance between the feature points in apex and neutral frame is determined and their difference in corresponding neutral and the apex frame is calculated to form the feature vector. The feature vectors thus formed for all the emotions and subjects are given to Random Forests and Support Vector Machine (SVM) for classification. We have compared the accuracy obtained by the two classifiers. Our proposed method is simple, uses only two frames and yields good accuracy for BU-4DFE database. We have determined optimum number of key facial points that could provide better recognition rate using the computed distance vectors. Our proposed method gives better results compared with literature and can be applied for real time implementation using SVM classifier and kinesics in future.

Keywords Facial emotions · Key feature points · Apex frame · Euclidean distance · Random forests · Support Vector Machine

1 Introduction

Since few decades scientists are keen to improve the communication between human and computers. Human computer interaction has become indispensable as
computing has become common in our daily life. To make an effective human computer interface, the interaction between them should be simple and easy as in human to human interaction. Emotions are fundamental to human beings and it plays a vital role in everyday life. The six basic emotions are anger, disgust, fear, happy, sad and surprise. Diverse applications include computer graphics, psychology, automatic driver fatigue detection, surveillance, etc. Emotion recognition consists of preprocessing, feature extraction and classification. In this work, we have used videos from BU-4DFE database, extracted neutral and apex frames automatically, extracted facial feature information that are contributing for recognizing emotions to form feature vector. They are given to classifiers for classification. We have implemented automatic retrieval of apex frame and with optimum number of feature points obtained encouraging accuracy. We have also determined optimum number of feature points as their selection plays an important role in recognizing emotions. Samples images with basic six emotions of BU-4DFE database are given in Fig. 1.

![Fig. 1 Six basic emotions from BU-4DFE Database (anger, disgust, fear, happy, sad and surprise).](image)

The reminder of this paper is organized as follows. In section 2, background work is discussed. In section 3, we present our proposed method. Result and analysis are given in section 4. Future work and conclusion are discussed in the last section.

## 2 Background Work

Various techniques have been proposed for emotion recognition during the last few decades. Not much work has been done in this area with respect to dynamic apex detection and emotion recognition using 4D videos. For emotion recognition using videos, the two approaches that are widely used for feature extraction are appearance based and geometry based. In geometric feature based methods, the facial components or facial feature points are extracted to form a feature vector that represents the face geometry. In appearance based methods, image filters, such as Gabor wavelets, are applied to either whole-face or specific regions in a face image to extract a feature vector [1]. To recognize the emotions accurately we need to calculate deformations occurred on the face by calculating the change in distance from eyes, mouth and nose. In the recent years, several emotion recognition algorithms have been proposed. In 2012 Sandbach [2] proposed a method that includes Iterative Closest Point (ICP), Free Form Deformation (FFD), vector projections and HMM classifier for recognizing emotions using BU-4DFE and also
compared the results with a similar 2D system. In 2012 Songfan [3] developed an emotional avatar image concept based on Active Appearance Models (AAM), Local Binary Patterns (LBP) using FERA 2011 database. Chuan proposed a method using geometric based approach that uses Euclidean distance, PCA and SVM [4]. ASM model is used to localize the points automatically where the shape information has been extracted from the images and it is used to compute the distance parameters and finally classified emotions using SVM classification. Anwar developed a model using facial Points Localization Model PDM, where they have determined drop in recognition rate using general neutral model [5].

Ben in 2014 [6] proposed an approach using radial curves and Riemannian shape analysis. Chiranjeevi in 2015 [7] proposed a method to dynamically learn the neutral appearance at key emotion points using statistical texture model in a continuous video sequence. Peng in 2015 [8] proposed head motions in videos based on SIFT classification using SVM. Most of the existing methods discussed in literature deals with images (or image sequences) with large variation in appearance of facial expressions, identifying these expressions are a significant research challenge in various disciplines ranging from entertainment to medical applications and affective computing. Finding the optimum number of key points which gives maximum recognition rate using geometric based approach is indispensable. Literature suggests that it is difficult to recognize emotion when pose and head movements are seen in videos, occlusion of objects or person moving randomly in videos, ambiguity and uncertainty in face motion, etc..

The methods proposed in this area of research are complex involving high computation. Various challenges in recognizing emotions are all the subjects will not express the motion at same time, detecting the apex frame is a challenging task because as the emotion varies continuously in a video sequence and it is difficult to detect the apex of an emotion. The most important challenge is to determine optimum number of points that could provide maximum recognition rate. In this paper, we have proposed a simple approach using Euclidean distance through which the distance of feature points between two frames under consideration are calculated which then form the feature vector and classified in to six basic emotions. We have also determined optimum number of points that could provide better recognition using few frames. Our approach gives good accuracy for Support Vector Machine (SVM) and Random Forests.

3 Proposed Method

We have used BU-4DFE database [9] for implementation. It consists of 101 subjects expressing anger, disgust, happiness, fear, sadness, and surprise. Each expression sequence contains approximately 100 frames depending upon the duration of the video. 3D facial expressions are captured at a video rate (25 frames per second). 83 feature points are provided for every frame of the video sequence. The database comprises 606 3D facial expression sequences, with a total of approximately 60,600 frame models. Each 3D model of a 3D video sequence has the resolution of approximately 35,000 vertices. The texture video has a resolution of about
1040×1329 pixels per frame. The database consists of 58 female and 43 male subjects, with a variety of ethnic/racial ancestries, including Asian, Black, Hispanic/Latino, and White. We have used the videos of all six emotions expressed by 60 subjects in our work. The steps involved in our proposed method are automatic peak detection, feature extraction, and classification which are explained in this section. The block diagram that describes the proposed method is shown in Fig. 2.

![Block Diagram of Proposed Method](image)

**Fig. 2** Proposed emotion recognition system for 4D videos

### 3.1 Automatic Peak Detection

In automatic peak detection, we extract the neutral and apex frames from each subject for each emotion. In BU-4DFE database the emotions posed by the various subjects has sequence of frames which starts with neutral expression and followed by apex of an expression and ends with neutral expression. In few subjects the frames start with apex expression and ends with neutral expression. We have developed a method which automatically identifies the apex expression from the sequence of frames. From the entire sequence of frames in the database for an emotion enacted by a subject, only few frames are considered and a method has been developed to automatically detect the apex frame by summing the Euclidean distances between the identified frames. We assume an integer variable ‘n’ which represents an interval between frames in a video sequence. The starting frame in the video sequence is numbered as 1 and frames of the order 1, 1n, 2n, 3n, etc., are selected till the last frame of the video sequence. 83 feature points are given in the database for each frame. For the selected frames, Euclidean distance is calculated for the corresponding 83 feature points between the frames 1 & 1n, 1 & 2n, 1 & 3n, 1 & 4n, 1 & 5n and so on. The Euclidean distance calculated between two frames, neutral and peak frames is given by (1).

\[
W = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2 + (x_i - x_j)^2}, \quad (i, j) \in [1, 83]
\]  

(1)

For example, if the number of frames in a video sequence is 65 and ‘n’ value is assumed as 5, then we select frames of the order 1,5,10,15,20,25,30………65. This