

ISSN 1726-5479

SENSORS & TRANSDUCERS

12

vol. 17
Special
/12



Sensors and Intelligent Systems

International Frequency Sensor Association Publishing



Guest Editor: Dr. Mohd Haris

Editors for Western Europe

Meijer, Gerard C.M., Delft University of Technology, The Netherlands
Ferrari, Vittorio, Università di Brescia, Italy

Editors for North America

Datskos, Panos G., Oak Ridge National Laboratory, USA
Fabien, J. Josse, Marquette University, USA
Katz, Evgeny, Clarkson University, USA

Editor South America

Costa-Felix, Rodrigo, Inmetro, Brazil

Editor for Eastern Europe

Sachenko, Anatoly, Ternopil State Economic University, Ukraine

Editor for Asia

Ohyama, Shinji, Tokyo Institute of Technology, Japan

Editor for Africa

Maki K.Habib, American University in Cairo, Egypt

Editor for Asia-Pacific

Mukhopadhyay, Subhas, Massey University, New Zealand

Editorial Advisory Board

- Abdul Rahim, Ruzairi, Universiti Teknologi, Malaysia
Ahmad, Mohd Noor, Northern University of Engineering, Malaysia
Annamalai, Karthigeyan, National Institute of Advanced Industrial Science and Technology, Japan
Arcega, Francisco, University of Zaragoza, Spain
Arguel, Philippe, CNRS, France
Ahn, Jae-Pyoung, Korea Institute of Science and Technology, Korea
Arndt, Michael, Robert Bosch GmbH, Germany
Ascoli, Giorgio, George Mason University, USA
Atalay, Selcuk, Inonu University, Turkey
Atghiaee, Ahmad, University of Tehran, Iran
Augutis, Vyngantas, Kaunas University of Technology, Lithuania
Avachit, Patil Lalchand, North Maharashtra University, India
Ayeshe, Aladdin, De Montfort University, UK
Azamimi, Azian binti Abdullah, Universiti Malaysia Perlis, Malaysia
Bahreyni, Behraad, University of Manitoba, Canada
Baliga, Shankar, B., General Monitors Transnational, USA
Baolian, Ye, Zhengzhou University, China
Barford, Lee, Agilent Laboratories, USA
Barlingay, Ravindra, RF Arrays Systems, India
Basu, Sukumar, Jadavpur University, India
Beck, Stephen, University of Sheffield, UK
Ben Bouzid, Sihem, Institut National de Recherche Scientifique, Tunisia
Benachaiba, Chellali, Universitaire de Bechar, Algeria
Binnie, T. David, Napier University, UK
Bischoff, Gerlinde, Inst. Analytical Chemistry, Germany
Bodas, Dhananjay, IMTEK, Germany
Borges Carval, Nuno, Universidade de Aveiro, Portugal
Bouchikhi, Benachir, University Moulay Ismail, Morocco
Bousbia-Salah, Mounir, University of Annaba, Algeria
Bouvet, Marcel, CNRS – UPMC, France
Bruzewski, Kazimierz, Warsaw University of Technology, Poland
Cai, Chenxin, Nanjing Normal University, China
Cai, Qingyun, Hunan University, China
Calvo-Gallego, Jaime, Universidad de Salamanca, Spain
Campanella, Luigi, University La Sapienza, Italy
Carvalho, Vitor, Minho University, Portugal
Cecelja, Franjo, Brunel University, London, UK
Cerdà Belmonte, Judith, Imperial College London, UK
Chakrabarty, Chandan Kumar, Universiti Tenaga Nasional, Malaysia
Chakravorty, Dipankar, Association for the Cultivation of Science, India
Changhai, Ru, Harbin Engineering University, China
Chaudhari, Gajanan, Shri Shivaji Science College, India
Chavali, Murthy, N.I. Center for Higher Education, (N.I. University), India
Chen, Jiming, Zhejiang University, China
Chen, Rongshun, National Tsing Hua University, Taiwan
Cheng, Kuo-Sheng, National Cheng Kung University, Taiwan
Chiang, Jeffrey (Cheng-Ta), Industrial Technol. Research Institute, Taiwan
Chiriac, Horia, National Institute of Research and Development, Romania
Chowdhuri, Arijit, University of Delhi, India
Chung, Wen-Yaw, Chung Yuan Christian University, Taiwan
Corres, Jesus, Universidad Publica de Navarra, Spain
Cortes, Camilo A., Universidad Nacional de Colombia, Colombia
Courtois, Christian, Université de Valenciennes, France
Cusano, Andrea, University of Sannio, Italy
D'Amico, Arnaldo, Università di Tor Vergata, Italy
De Stefano, Luca, Institute for Microelectronics and Microsystem, Italy
Deshmukh, Kiran, Shri Shivaji Mahavidyalaya, Barshi, India
Dickert, Franz L., Vienna University, Austria
Dieguez, Angel, University of Barcelona, Spain
Dighavkar, C. G., M.G. Vidyamandir's L. V.H. College, India
Dimitropoulos, Panos, University of Thessaly, Greece
Ding, Jianning, Jiangsu Polytechnic University, China
Djordjevic, Alexander, City University of Hong Kong, Hong Kong
Donato, Nicola, University of Messina, Italy
Donato, Patricio, Universidad de Mar del Plata, Argentina
Dong, Feng, Tianjin University, China
Drljaca, Predrag, Instersema Sensoric SA, Switzerland
Dubey, Venketesh, Bournemouth University, UK
Enderle, Stefan, Univ.of Ulm and KTB Mechatronics GmbH, Germany
Erdem, Gursan K. Arzum, Ege University, Turkey
Erkmen, Aydan M., Middle East Technical University, Turkey
Estelle, Patrice, Insa Rennes, France
Estrada, Horacio, University of North Carolina, USA
Faiz, Adil, INSA Lyon, France
Fericean, Sorin, Balluff GmbH, Germany
Fernandes, Joana M., University of Porto, Portugal
Francioso, Luca, CNR-IMM Institute for Microelectronics and Microsystems, Italy
Francis, Laurent, University Catholique de Louvain, Belgium
Fu, Weiling, South-Western Hospital, Chongqing, China
Gaura, Elena, Coventry University, UK
Geng, Yanfeng, China University of Petroleum, China
Gole, James, Georgia Institute of Technology, USA
Gong, Hao, National University of Singapore, Singapore
Gonzalez de la Rosa, Juan Jose, University of Cadiz, Spain
Granel, Annette, Goteborg University, Sweden
Graff, Mason, The University of Texas at Arlington, USA
Guan, Shan, Eastman Kodak, USA
Guillet, Bruno, University of Caen, France
Guo, Zhen, New Jersey Institute of Technology, USA
Gupta, Narendra Kumar, Napier University, UK
Hadjiloucas, Sillas, The University of Reading, UK
Haider, Mohammad R., Sonoma State University, USA
Hashsham, Syed, Michigan State University, USA
Hasni, Abdelhafid, Bechar University, Algeria
Hernandez, Alvaro, University of Alcalá, Spain
Hernandez, Wilmar, Universidad Politecnica de Madrid, Spain
Homentcovschi, Dorel, SUNY Binghamton, USA
Horstman, Tom, U.S. Automation Group, LLC, USA
Hsiai, Tzung (John), University of Southern California, USA
Huang, Jeng-Sheng, Chung Yuan Christian University, Taiwan
Huang, Star, National Tsing Hua University, Taiwan
Huang, Wei, PSG Design Center, USA
Hui, David, University of New Orleans, USA
Jaffrezic-Renault, Nicole, Ecole Centrale de Lyon, France
James, Daniel, Griffith University, Australia
Janting, Jakob, DELTA Danish Electronics, Denmark
Jiang, Liudi, University of Southampton, UK
Jiang, Wei, University of Virginia, USA
Jiao, Zheng, Shanghai University, China
John, Joachim, IMEC, Belgium
Kalach, Andrew, Voronezh Institute of Ministry of Interior, Russia
Kang, Moonho, Sunmoon University, Korea South
Kaniusas, Eugenijus, Vienna University of Technology, Austria
Katake, Anup, Texas A&M University, USA
Kausel, Wilfried, University of Music, Vienna, Austria
Kavasoglu, Nese, Mugla University, Turkey
Ke, Cathy, Tyndall National Institute, Ireland
Khelfaoui, Rachid, Université de Bechar, Algeria
Khan, Asif, Aligarh Muslim University, Aligarh, India
Kim, Min Young, Kyungpook National University, Korea South
Ko, Sang Choon, Electronics. and Telecom. Research Inst., Korea South
Kotulska, Malgorzata, Wroclaw University of Technology, Poland
Kockar, Hakan, Balikesir University, Turkey
Kong, Ing, RMIT University, Australia
Kratz, Henrik, Uppsala University, Sweden

Krishnamoorthy, Ganesh, University of Texas at Austin, USA
Kumar, Arun, University of Delaware, Newark, USA
Kumar, Subodh, National Physical Laboratory, India
Kung, Chih-Hsien, Chang-Jung Christian University, Taiwan
Lacnjevac, Caslav, University of Belgrade, Serbia
Lay-Ekuakille, Aime, University of Lecce, Italy
Lee, Jang Myung, Pusan National University, Korea South
Lee, Jun Su, Amkor Technology, Inc. South Korea
Lei, Hua, National Starch and Chemical Company, USA
Li, Fengyuan (Thomas), Purdue University, USA
Li, Genxi, Nanjing University, China
Li, Hui, Shanghai Jiaotong University, China
Li, Sihua, Agiltron, Inc., USA
Li, Xian-Fang, Central South University, China
Li, Yuefa, Wayne State University, USA
Liang, Yuanchang, University of Washington, USA
Liawruangrath, Saisunee, Chiang Mai University, Thailand
Liew, Kim Meow, City University of Hong Kong, Hong Kong
Lin, Hermann, National Kaohsiung University, Taiwan
Lin, Paul, Cleveland State University, USA
Linderholm, Pontus, EPFL - Microsystems Laboratory, Switzerland
Liu, Aihua, University of Oklahoma, USA
Liu Changgeng, Louisiana State University, USA
Liu, Cheng-Hsien, National Tsing Hua University, Taiwan
Liu, Songqin, Southeast University, China
Lodeiro, Carlos, University of Vigo, Spain
Lorenzo, Maria Encarnacio, Universidad Autonoma de Madrid, Spain
Lukaszewicz, Jerzy Pawel, Nicholas Copernicus University, Poland
Ma, Zhanfang, Northeast Normal University, China
Majstorovic, Vidosav, University of Belgrade, Serbia
Malyshev, V.V., National Research Centre 'Kurchatov Institute', Russia
Marquez, Alfredo, Centro de Investigacion en Materiales Avanzados, Mexico
Matay, Ladislav, Slovak Academy of Sciences, Slovakia
Mathur, Prafull, National Physical Laboratory, India
Maurya, D.K., Institute of Materials Research and Engineering, Singapore
Mekid, Samir, University of Manchester, UK
Melnyk, Ivan, Photon Control Inc., Canada
Mendes, Paulo, University of Minho, Portugal
Mennell, Julie, Northumbria University, UK
Mi, Bin, Boston Scientific Corporation, USA
Minas, Graca, University of Minho, Portugal
Mishra, Vivekanand, National Institute of Technology, India
Moghavvemi, Mahmoud, University of Malaya, Malaysia
Mohammadi, Mohammad-Reza, University of Cambridge, UK
Molina Flores, Esteban, Benemérita Universidad Autónoma de Puebla, Mexico
Moradi, Majid, University of Kerman, Iran
Morello, Rosario, University "Mediterranea" of Reggio Calabria, Italy
Mounir, Ben Ali, University of Sousse, Tunisia
Mrad, Nezh, Defence R&D, Canada
Mulla, Imtiaz Sirajuddin, National Chemical Laboratory, Pune, India
Nabok, Aleksey, Sheffield Hallam University, UK
Neelamegam, Periasamy, Sastra Deemed University, India
Neshkova, Milka, Bulgarian Academy of Sciences, Bulgaria
Oberhammer, Joachim, Royal Institute of Technology, Sweden
Ould Lahoucine, Cherif, University of Guelma, Algeria
Pamidighanta, Sayanu, Bharat Electronics Limited (BEL), India
Pan, Jisheng, Institute of Materials Research & Engineering, Singapore
Park, Joon-Shik, Korea Electronics Technology Institute, Korea South
Passaro, Vittorio M. N., Politecnico di Bari, Italy
Penza, Michele, ENEA C.R., Italy
Pereira, Jose Miguel, Instituto Politecnico de Setebal, Portugal
Petsev, Dimiter, University of New Mexico, USA
Pogacnik, Lea, University of Ljubljana, Slovenia
Post, Michael, National Research Council, Canada
Prance, Robert, University of Sussex, UK
Prasad, Ambika, Gulbarga University, India
Prateepasen, Asa, Kingmoungut's University of Technology, Thailand
Pugno, Nicola M., Politecnico di Torino, Italy
Pullini, Daniele, Centro Ricerche FIAT, Italy
Pumera, Martin, National Institute for Materials Science, Japan
Radhakrishnan, S., National Chemical Laboratory, Pune, India
Rajanna, K., Indian Institute of Science, India
Ramadan, Qasem, Institute of Microelectronics, Singapore
Rao, Basuthkar, Tata Inst. of Fundamental Research, India
Raouf, Kosai, Joseph Fourier University of Grenoble, France
Rastogi Shiva, K., University of Idaho, USA
Reig, Candid, University of Valencia, Spain
Restivo, Maria Teresa, University of Porto, Portugal
Robert, Michel, University Henri Poincare, France
Rezazadeh, Ghader, Urmia University, Iran
Royo, Santiago, Universitat Politècnica de Catalunya, Spain
Rodriguez, Angel, Universitat Politècnica de Catalunya, Spain
Rothberg, Steve, Loughborough University, UK
Sadana, Ajit, University of Mississippi, USA
Sadeghian Marnani, Hamed, TU Delft, The Netherlands
Sapozhnikova, Ksenia, D.I.Mendeleyev Institute for Metrology, Russia
Sandacci, Serghei, Sensor Technology Ltd., UK
Saxena, Vibha, Bbhba Atomic Research Centre, Mumbai, India
Schneider, John K., Ultra-Scan Corporation, USA
Sengupta, Deepak, Advance Bio-Photonics, India
Seif, Selemani, Alabama A & M University, USA
Seifter, Achim, Los Alamos National Laboratory, USA
Shah, Kriyang, La Trobe University, Australia
Sankarraaj, Anand, Detector Electronics Corp., USA
Silva Giroa, Pedro, Technical University of Lisbon, Portugal
Singh, V. R., National Physical Laboratory, India
Slomovitz, Daniel, UTE, Uruguay
Smith, Martin, Open University, UK
Soleimanpour, Amir Masoud, University of Toledo, USA
Soleymanpour, Ahmad, University of Toledo, USA
Somani, Prakash R., Centre for Materials for Electronics Technol., India
Sridharan, M., Sastra University, India
Srinivas, Talabattula, Indian Institute of Science, Bangalore, India
Srivastava, Arvind K., NanoSonix Inc., USA
Stefan-van Staden, Raluca-Ioana, University of Pretoria, South Africa
Stefanescu, Dan Mihai, Romanian Measurement Society, Romania
Sumriddetchka, Sarun, National Electronics and Comp. Technol. Center, Thailand
Sun, Chengliang, Polytechnic University, Hong-Kong
Sun, Dongming, Jilin University, China
Sun, Junhua, Beijing University of Aeronautics and Astronautics, China
Sun, Zhiqiang, Central South University, China
Suri, C. Raman, Institute of Microbial Technology, India
Sysoev, Victor, Saratov State Technical University, Russia
Szewczyk, Roman, Industr. Research Inst. for Automation and Measurement, Poland
Tan, Ooi Kiang, Nanyang Technological University, Singapore
Tang, Dianping, Southwest University, China
Tang, Jaw-Luen, National Chung Cheng University, Taiwan
Teker, Kasif, Frostburg State University, USA
Thirunavukkarasu, I., Manipal University Karnataka, India
Thumbavanam Pad, Kartik, Carnegie Mellon University, USA
Tian, Gui Yun, University of Newcastle, UK
Tsiantos, Vassilios, Technological Educational Institute of Kaval, Greece
Tsigara, Anna, National Hellenic Research Foundation, Greece
Twomey, Karen, University College Cork, Ireland
Valente, Antonio, University, Vila Real, - U.T.A.D., Portugal
Vanga, Raghav Rao, Summit Technology Services, Inc., USA
Vaseashta, Ashok, Marshall University, USA
Vazquez, Carmen, Carlos III University in Madrid, Spain
Vieira, Manuela, Instituto Superior de Engenharia de Lisboa, Portugal
Vigna, Benedetto, STMicroelectronics, Italy
Vrba, Radimir, Brno University of Technology, Czech Republic
Wandelt, Barbara, Technical University of Lodz, Poland
Wang, Jiangping, Xi'an Shiyou University, China
Wang, Kedong, Beihang University, China
Wang, Liang, Pacific Northwest National Laboratory, USA
Wang, Mi, University of Leeds, UK
Wang, Shinn-Fwu, Ching Yun University, Taiwan
Wang, Wei-Chih, University of Washington, USA
Wang, Wensheng, University of Pennsylvania, USA
Watson, Steven, Center for NanoSpace Technologies Inc., USA
Weiping, Yan, Dalian University of Technology, China
Wells, Stephen, Southern Company Services, USA
Wolkenberg, Andrzej, Institute of Electron Technology, Poland
Woods, R. Clive, Louisiana State University, USA
Wu, DerHo, National Pingtung Univ. of Science and Technology, Taiwan
Wu, Zhaoyang, Hunan University, China
Xiu Tao, Ge, Chuzhou University, China
Xu, Lisheng, The Chinese University of Hong Kong, Hong Kong
Xu, Sen, Drexel University, USA
Xu, Tao, University of California, Irvine, USA
Yang, Dongfang, National Research Council, Canada
Yang, Shuang-Hua, Loughborough University, UK
Yang, Wuqiang, The University of Manchester, UK
Yang, Xiaoling, University of Georgia, Athens, GA, USA
Yaping Dan, Harvard University, USA
Ymeti, Aurel, University of Twente, Netherland
Yong Zhao, Northeastern University, China
Yu, Haihu, Wuhan University of Technology, China
Yuan, Yong, Massey University, New Zealand
Yufera Garcia, Alberto, Seville University, Spain
Zakaria, Zulkarnay, University Malaysia Perlis, Malaysia
Zagnoni, Michele, University of Southampton, UK
Zamani, Cyrus, Universitat de Barcelona, Spain
Zeni, Luigi, Second University of Naples, Italy
Zhang, Minglong, Shanghai University, China
Zhang, Qintao, University of California at Berkeley, USA
Zhang, Weiping, Shanghai Jiao Tong University, China
Zhang, Wenming, Shanghai Jiao Tong University, China
Zhang, Xueji, World Precision Instruments, Inc., USA
Zhong, Haoxiang, Henan Normal University, China
Zhu, Qing, Fujifilm Dimatix, Inc., USA
Zorzano, Luis, Universidad de La Rioja, Spain
Zourob, Mohammed, University of Cambridge, UK

Contents

Volume 17
Special Issue
December 2012

www.sensorsportal.com

ISSN 1726-5479

Research Articles

Foreword

Dr. Mohd Haris, Md Khir 1

Modeling and Layout Design of Resonant Lateral Comb Magnetic Sensor

F. Ahmad, J. O. Dennis, M. H. Md Khir and N. H. Hamid 1

DC Characterization and Post-CMOS Processing of a Microcantilever Sensor

A. Mirza, N. H. Hamid, M. H. Md. Khir, J. O. Dennis, K. Ashraf 13

Enhanced Performances of a Wireless System-on-Chip for MEMS Biomedical Plantar Pressure Sensor

Abdul Hadi Abdul Razak and Yufridin Wahab 22

Simulation of Liquid Material for Microfluidic-based Acoustic Sensor

M. F. A. Rahman, M. R. Arshad and A. A. Manaf 30

Design, Simulation and Fabrication of a Mass Sensitive CMOS-MEMS Resonator

A. Y. Ahmed, J. O. Dennis, M. H. Md Khir, M. N. Mohamad Saad and M. R. Buyong 40

Artificial Neural Network-based Electronic Nose for the Detection of Sulfate-reducing Bacteria

Earn Tzeh Tan, Zaini Abdul Halim, Darah Ibrahim, Rashidah Abdul Rahim, Junita Mohamad Saleh, Umadevi Chandaran 50

Microcontroller Based Neural Network for Landmine Detection Using Magnetic Gradient Data

Mohamed Elkattan, Ahmed Salem, Fouad Solima, Aladin Kamel and Hadia El-Hennawy 60

An Intelligent ANN Based Control of A Quasi Six-Phase Voltage Source Inverter

Mohammad Shahid Jamil, Mohammad Ibrahim Al-Naemi, Mohd. Arif Khan, Atif Iqbal, Shaikh Moinuddin 70

Comparative Study and Analysis of Suspension Systems using Adaptive Fuzzy Control

LAIQ Khan and M. Umair Khan 81

Development of NOx Emission Model Using Particle Swarm Optimized Least-Squared SVR (PSO-LSSVR) Hybrid Algorithm

Elangeshwaran Pathmanathan, Rosdiazli Ibrahim, Vijanth Asirvadam 98

Development and Implementation of Hybrid Controllers for Flow Control Application

M. Iqbal Ab Ghafar, R. Ibrahim, Zulfadhli Mazlan 110

Capability of Optical Approach in Condition Based Monitoring of Lubricant Oil

M. F. M. Idros, Hadzli Hashim, Md. Shabiul Islam, Sawal Hamid Ali 125

Extracting Broadband Tissue Optics Parameters from One Source-Detector CW Diffuse Optical Spectroscopy <i>Aulia Nasution</i>	135
A Low Ripple Charge Pump Using Low-Voltage CMOS Process <i>Lee Fu New, Zulfiqar Ali bin Abdul Aziz and Mun Fook Leong</i>	147
Experimental Study on a Directional Cylindrical Dielectric Resonator Antenna (CDRA) At 5 to 6 GHz <i>M. A. Zakariya, Z. Baharudin, M. H. Md Khir, A. J. Jamali, M. F. Ain, Z. A. Ahmad</i>	158
RF Energy Harvester: Harvesting Power from WiFi Signals for Low Power RFID Application <i>S. S. B. Hong, R. Ibrahim, M. H. Md Khir, M. A Zakariya, H. Daud</i>	168
Analytical Investigation of Frequency Dependence of Average Power of a Vibration Energy Harvester <i>K. Ashraf, M. H. Md. Khir, J. O. Dennis</i>	176
Trapezoidal Electrodes Array for Electret-Based Electrostatic Energy Harvester <i>Mohamad Radzi Ahmad and Mohd Haris Md Khir</i>	186
Power Management for USB2.0 5 V Supply Using Load Resistive and Switch Capacitive Detection Approach <i>Tan Thiam Loong, Dr. Anwar Hasni bin Abu Hassan</i>	199
DSP Sensorless Controller of Switched Reluctance Motor-Generator Approaching to AM Modulation <i>A. Moraveji, A. Siadatan, E. Afjei, M. Rafiee and E. Zarei Ali Abadi</i>	208
Optimal Feedforward Zero Phase Error Tracking Control for High Precision X-Y Table <i>Hashimah Ismail, Norlela Ishak, Mazidah Tajjudin, Mohd Hezri Fazalul Rahiman, Ramli Adnan</i>	217
Implementation and Optimization of Human Tracking System Using ARM Embedded Platform <i>Shen Khang Teoh, Vooi Voon Yap, Chit Siang Soh, Patrick Sebastian</i>	226
Effectiveness of the Polymer Electrolyte Membrane Fuel Cell in High Humidity Climate <i>Z. Jalauddin, N. M. Nor, T. Ibrahim, and Y. T. Sin</i>	234
Permittivity and Conductivity Dispersions of Properly and Non-properly Slaughtered Goat Meat <i>Abdullah MOHIRI, Zainal Arif BURHANUDIN and Idris ISMAIL</i>	247
Utilizing Bi₂Te₃ TE Pellet as the Condenser of Thermal Power Plant <i>M. Rafiee, A. Siadatan, E. Zarei Ali Abadi and E. Afjei</i>	257

Authors are encouraged to submit article in MS Word (doc) and Acrobat (pdf) formats by e-mail: editor@sensorsportal.com
Please visit journal's webpage with preparation instructions: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm>



The Fourth International Conference on Sensor Device Technologies and Applications

SENSORDEVICES 2013

25 - 31 August 2013 - Barcelona, Spain

Tracks: Sensor devices - Ultrasonic and Piezosensors - Photonics - Infrared - Gas Sensors - Geosensors - Sensor device technologies - Sensors signal conditioning and interfacing circuits - Medical devices and sensors applications - Sensors domain-oriented devices, technologies, and applications - Sensor-based localization and tracking technologies - Sensors and Transducers for Non-Destructive Testing

Deadline for papers: 30 March 2013

<http://www.aria.org/conferences2013/SENSORDEVICES13.html>



The Seventh International Conference on Sensor Technologies and Applications

**Deadline for papers:
30 March 2013**

SENSORCOMM 2013

25 - 31 August 2013 - Barcelona, Spain

Tracks: Architectures, protocols and algorithms of sensor networks - Energy, management and control of sensor networks - Resource allocation, services, QoS and fault tolerance in sensor networks - Performance, simulation and modelling of sensor networks - Security and monitoring of sensor networks - Sensor circuits and sensor devices - Radio issues in wireless sensor networks - Software, applications and programming of sensor networks - Data allocation and information in sensor networks - Deployments and implementations of sensor networks - Under water sensors and systems - Energy optimization in wireless sensor networks

<http://www.aria.org/conferences2013/SENSORCOMM13.html>



The Sixth International Conference on Advances in Circuits, Electronics and Micro-electronics

CENICS 2013

25 - 31 August 2013 - Barcelona, Spain

Deadline for papers: 30 March 2013

Tracks: Semiconductors and applications - Design, models and languages - Signal processing circuits - Arithmetic computational circuits - Microelectronics - Electronics technologies - Special circuits - Consumer electronics - Application-oriented electronics

<http://www.aria.org/conferences2013/CENICS13.html>

Development and Implementation of Hybrid Controllers for Flow Control Application

M. Iqbal Ab Ghafar, R. Ibrahim, Zulfadhli Mazlan

Electrical and Electronic Engineering Department,
Universiti Teknologi PETRONAS

Bandar Seri Iskandar, 31720 Tronoh, Perak, Malaysia

Tel.: +605 368 7821, fax: +605 364 7443

E-mail: iqbalghafar@gmail.com, rosdiazli@petronas.com.my, zulfadhlimazlan@gmail.com

Received: 29 September 2012 /Accepted: 29 October 2012 /Published: 18 December 2012

Abstract: The main objective of this paper is to design and implement Hybrid Controllers, which consist of Adaptive Fuzzy PID Controller (AFPIDC) and Adaptive Neuro-Fuzzy Inference System (ANFIS) for flow control application. The implementation has been accomplished onto mobile pilot plant for flow control process unit. Currently, controlling and tuning is done via KONICS PID controller that is mounted on the local control panel. However, it is unable to provide adequate response and need to be manually tuned. Thus, the AFPIDC and ANFIS are developed and implemented as alternatives to the existing PID controller with the capability of Human Machine Interface (HMI) using MATLAB/Simulink. For AFPIDC, Fuzzy Logic reasoning is used to produce adaptive PID gain while for ANFIS; Fuzzy Logic will be tuned by using Artificial Neural Network (ANN) algorithm. Overall, the control performances for PID, AFPIDC and ANFIS will be compared and analyzed for flow control application. *Copyright © 2012 IFSA.*

Keywords: Adaptive fuzzy PID controller, ANFIS, Flow control, Fuzzy logic controller, Artificial neural network, PID controller.

1. Introduction

Control refers to those things that maintain a desired system output by altering the flow of energy from the source to the output device. Thus, control will provide influences to the final outcome of a process or operation. The fundamental of any control system is the ability to measure the output of the system and take any necessary action for the correction if the measured values deviate from the desired values. Basically, a feedback control system will have several elements such as controller, final element (control valve), plant and sensors [1].

PID controller is one of the conventional controllers that are widely used in process industries due to its simplicity and effectiveness for linear system, especially for first and second order system [18]. Unfortunately, it cannot function well for non-linear systems. In order to find a controller that can give good performances for both situations, two types of hybrid controllers which are AFPIDC and ANFIS will be designed and implemented. AFPIDC is one of the new hybrid controllers that the PID parameters are adjusted by fuzzy rules in real-time [4]. The Fuzzy Logic Controller (FLC) is used to produce three auxiliary outputs which are proportional, integral and derivative operating units [$\Delta e_p(t)$, $\Delta e_i(t)$ and $\Delta e_d(t)$]. The inputs of the controller are composed of error, e and rate change of error, de/dt . The main input signal is the weighted system error and the weights are the additional PID parameters with fixed gains tuned in a traditional way. Since the output of the fuzzy logic controller is changeable, the gain of the controller is adjusted implicitly and adaptively. ANFIS is a combination between Fuzzy Logic and ANN which is capable to generate expert system by itself. By using ANN learning ability, ANFIS provide a method for the fuzzy logic to learn information about the data set in order to compute the best membership parameters that can track the given input – output data [18]. Simply put, ANN is a tuning method for FLC.

2. Problem Statement

The pilot plant currently uses a PID controller which is mounted locally on the local control panel for controlling purposes. However, the existing PID controller exhibit slow settling time and rise time and it will worsen when the system become non-linear due to the presence of disturbances. In addition, the designer needs to do mathematical calculations in order to fine tune the PID controller and it will have poor performance if the parameters are improperly tuned. Besides that, the pilot plant does not have DCS – HMI interface system on the local control panel for monitoring and recording of the process control. This has made the monitoring, controlling and tuning of the flow control application of the pilot plant to be more difficult and impractical. Therefore, in order to overcome these problems, new hybrid controllers; AFPIDC and ANFIS are proposed so that the new controllers hopefully will provide better control performance and will be more robust. In addition the HMI will be developed via MATLAB/Simulink for monitoring, controlling and tuning purposes.

3. Objectives

Some objectives have been outlined to support the aim of this research. Amongst others is to investigate, design and develop AFPIDC and ANFIS for flow control pilot plant. Besides that, the idea is to make some analysis and comparison between PID, AFPIDC and ANFIS in terms of their control performance.

It is good to highlight that all investigation will be based on the Mobile Pilot Plant and MATLAB/Simulink as the main software. A USB Data Acquisition card will be utilized in receiving controlled variables from the plant and transmitting manipulated variables to the pilot plant.

4. Literature Review

2.1. Adaptive Fuzzy PID Controller (AFPIDC)

Adaptive Fuzzy PID Controller (AFPIDC) is one of the hybrid controller that combine both PID controller and Fuzzy Logic controller (FLC). FLC is used to produce three operating units

(proportional, integral and derivative operating units) that make the PID gains proposed to be adapted implicitly [4]. It can be best illustrated as in Fig. 1.

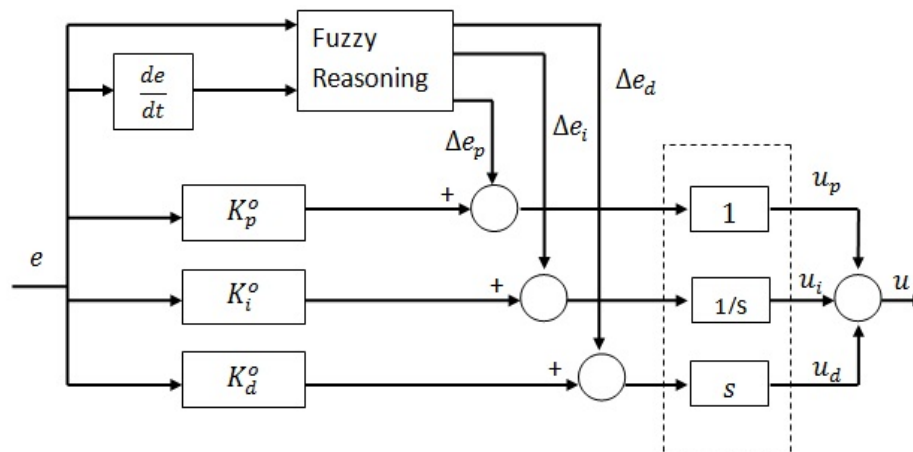


Fig. 1. Proposed AFPIDC.

The initial PID controller can be equivalently represented as:

$$u^0(t) = K_p^0 e(t) + K_i^0 \int_0^t e(\tau) d\tau + K_d^0 de(t)/dt \quad (1)$$

The parameters in Equation 1 which are K_p^0 , K_i^0 and K_d^0 are time invariant constants where it is the initial PID gain obtained earlier. The output of initial PID gain is $u^0(t)$.

Then using Fuzzy Logic controller, the output of the FLC is the adaption of PID gain as:

$$\Delta u(t) = \Delta e_p(t) + \int_0^t \Delta e_i(\tau) d\tau + \frac{d[\Delta e_d(t)]}{dt} \quad (2)$$

Finally, adaptive Fuzzy PID controller (AFPIDC) uses the combination of initial PID gain from Equation 1 with the adaptive PID gain from Equation 2.

$$u(t) = [K_p^0 + \Delta e_p]e(t) + \int_0^t [K_i^0 + \Delta e_i(\tau)]e(\tau) d\tau + \frac{d[K_d^0 + \Delta e_d(t)]e(t)}{dt} \quad (3)$$

$$u(t) = \Delta u(t) + u^0(t)$$

From Equation 3, the output of initial PID controller gain ($u^0(t)$) and output of FLC which is adaptive PID gain ($\Delta u(t)$) will be summed together to produce main output of the AFPIDC which is $u(t)$. Thus, the implicit adaption approach is not to make the parameters of PID controller adaptive but produce adaptively a series of signals in such a way that the PID parameters K_p^0 , K_i^0 and K_d^0 is implicitly adaptive [3].

2.2. Adaptive Neuro-Fuzzy Inference System (ANFIS)

Adaptive Neural-Fuzzy Inference System (ANFIS) was developed by Roger Jang in 1993. It is a combination between Fuzzy Logic and Artificial Neural Network (ANN). Below is the architecture for ANFIS controller.

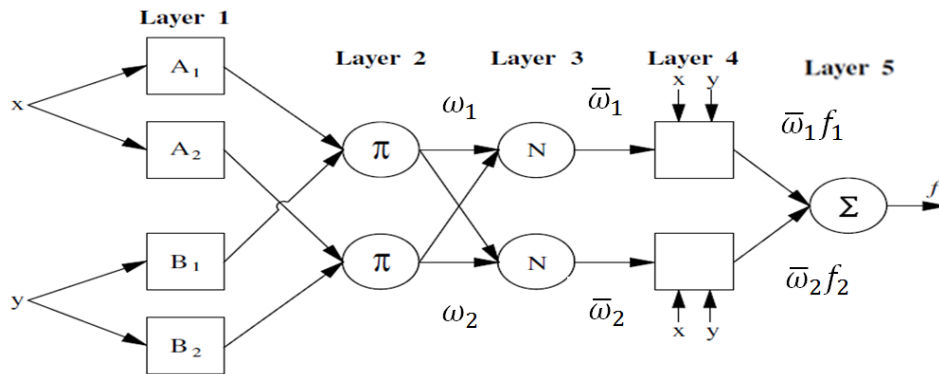


Fig. 2. ANFIS Architecture.

The circular nodes represent nodes that are fixed whereas the square nodes have parameters to be learnt / adjusted. This model will provide:

- RHS (*consequent parameters*) tuning by implementing the first order Takagi-Sugeno fuzzy logic as a network;
- LHS (*premise parameters*) tuning by using back-propagation algorithm.

The above system has x and y as inputs while f is the output function. The system contains two rules of Takagi-Sugeno type.

Rule 1: If x is A_1 and y is B_1 , then $f_1 = p_1x + q_1y + r_1$

Rule 2: If x is A_2 and y is B_2 , then $f_2 = p_2x + q_2y + r_2$

Each node of each layer in the ANFIS structure has same function family as described below:

Layer 1

The output of each node is:

$$\begin{aligned} O_{1,i} &= \mu_{A_i}(x) && \text{for } i = 1,2 \\ O_{1,i} &= \mu_{B_{i-2}}(y) && \text{for } i = 3,4 \end{aligned} \quad (4)$$

$O_{1,i}(x)$ is the membership degree for x and y inputs. The membership functions can be any shape but for illustration purposes, bell shaped function will be used which is given by:

$$\mu_A(x) = \frac{1}{1 + \left| \frac{x - c_i}{a_i} \right|^{2b_i}}, \quad (5)$$

where a_i, b_i, c_i are parameters to be adjusted. These are the *premise parameters*.

Layer 2

Every node parameters in this layer is fixed. This is where the t-norm is used to ‘AND’ the membership degree.

$$O_{2,i} = w_i = \mu_{A_i}(x)\mu_{B_i}(y), \quad i = 1,2 \quad (6)$$

Layer 3

Layer 3 also contains fixed nodes which calculate the ratio of the firing strengths of the rules:

$$O_{3,i} = \bar{w}_i = \frac{w_i}{w_1 + w_2} \quad (7)$$

Layer 4

The nodes in this layer are adaptive and perform the consequent of the rules:

$$O_{4,i} = \bar{w}_i f_i = \bar{w}_i (p_i x + q_i y + r_i) \quad (8)$$

The parameters in this layer (p_i, q_i, r_i) are to be determined and are referred to as the *consequent parameters*.

Layer 5

There is a single node here that computes the overall output [17, 18]:

$$O_{5,i} = \sum_i \bar{w}_i f_i = \frac{\sum_i w_i f_i}{\sum_i w_i} \quad (9)$$

3. Hardware and Tools

- PcASimExpert Mobile Pilot Plant SE 231B-21 - Flow Control and Calibration Process Unit
- A desktop
- Data Acquisition Card (DAQ); USB-1208FS
- Matlab with Data Acquisition, Fuzzy Logic and ANFIS Toolboxes

Connection between pilot plant with the PC using DAQ card is shown in Fig. 3.

4. Controllers Development**4.1. Designing AFPIDC**

Fuzzy Inference System (FIS) for the AFPIDC is designed using Fuzzy Logic Toolbox in MATLAB/Simulink. Using Mamdani approach, there are two inputs to the FIS which are error, E and rate of change of error, $delE$. The FIS will produce three outputs as shown in Fig. 1. The three outputs $[\Delta e_p(t), \Delta e_i(t), \Delta e_d(t)]$ will be added with the conventional PID gains which are $[K_p^0, K_i^0, K_d^0]$.

The output of the controller is the control signals to the control valve which is the manipulated variable, mv . The input – output relationships are used to develop the IF-THEN rules for the fuzzy inference system (FIS). There are 49 rules created using Fuzzy Logic reasoning for each of the FIS. However, the rules can be made larger as it will ensure better control performance with better accuracy even when there are smaller errors. The relationship between inputs and output are shown in Tables 1 and 2.



Fig. 3. Plant Setup.

Table 1. FIS for adaptive Proportional gain.

$\Delta e/E$ \ E	NB	NM	NS	Z	PS	PM	PB
NB	PB	PB	PM	Z	PS	PS	Z
NM	PB	PB	PM	Z	PS	Z	Z
NS	PM	PM	NM	Z	Z	NS	NM
Z	PM	PS	PS	Z	NS	NM	NM
PS	PS	PS	Z	Z	NS	NM	NM
PM	Z	Z	NS	Z	NM	NM	NB
PB	Z	NS	NS	Z	NM	NB	NB

Table 2. FIS for adaptive Integral gain.

$\Delta e/E$ \ E	NB	NM	NS	Z	PS	PM	PB
NB	NB	NB	NB	NM	NM	Z	Z
NM	NB	NB	NM	NM	NS	Z	Z
NS	NM	NM	NS	NS	Z	PS	PS
Z	NM	NS	NS	Z	PS	PS	PM
PS	NS	NS	Z	PS	PS	PM	PM
PM	Z	Z	PS	PM	PM	PB	PB
PB	Z	Z	PS	PM	PB	PB	PB

FIS for Δe_d will be considered as zero because for this project, the Derivative operating unit is not needed. The reason for this is because the flow control application is the fastest control application than pressure, level and temperature control application. The derivative action will provide the controller rapid and faster response to compensate the error. Therefore for flow control application, it does need to have derivative action as it does not have a capacity to be filled before it can respond to

changes given. Thus, for this project, the PID controller is actually PI controller without Derivative action to avoid unstable controller response.

The inputs, E and $delE$, and output, MV has seven membership functions i.e. negative big (NB), negative medium (NM), negative small (NS), zero (Z), positive small (PS), positive medium (PM) and positive big (PB). From the Fig. 5, the range for the first input, E , is [-50 50] following the range of operation for Orifice Flow meter in the plant which is set from 15 l/min to 45 l/min . The valve operation is non-linear in nature as can be seen from Fig. 4 will provide best linearity from 29 % to 70 % of opening.

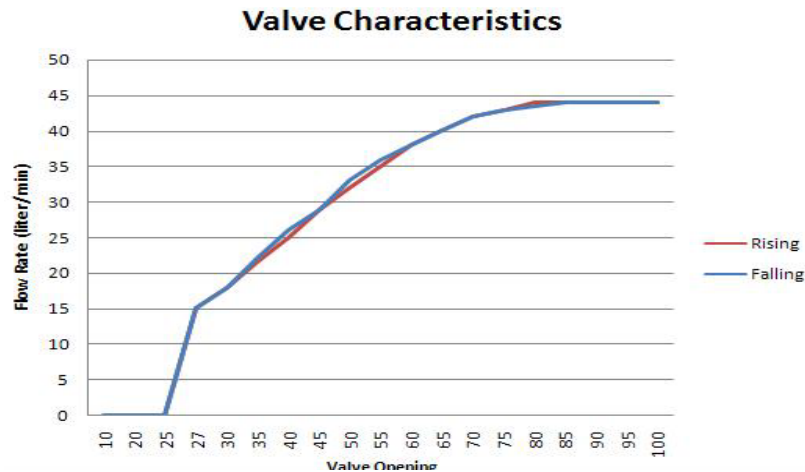


Fig. 4. Control Valve Characteristic for Orifice Flow Meter.

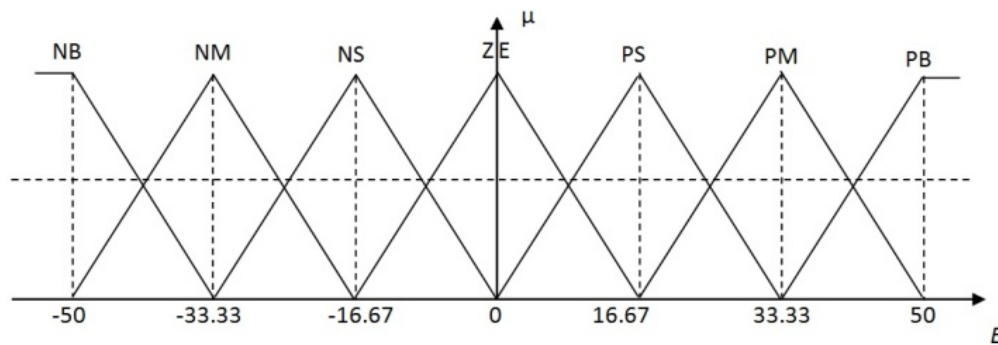


Fig. 5. Membership Function for error, e .

The error would not exceed ± 20 l/min , because the largest set point change can only be ± 20 l/min . For the second input in Fig. 6, $delE$, the range is chosen at [-20 20] because during in the empirical modeling stage, the change in error is found to be averaging around ± 20 l/min when there is a step change in the set point.

Meanwhile for the output, the range is [-0.2 0.2] which can be seen in Fig. 7. The output of the controller will be accumulated and added together with the value of initial PID gain before it is fed to the control valve. The output range must not be too large as it will provide too aggressive response that caused the control to be unstable and not too small as it will not have enough “kick” and slower response.

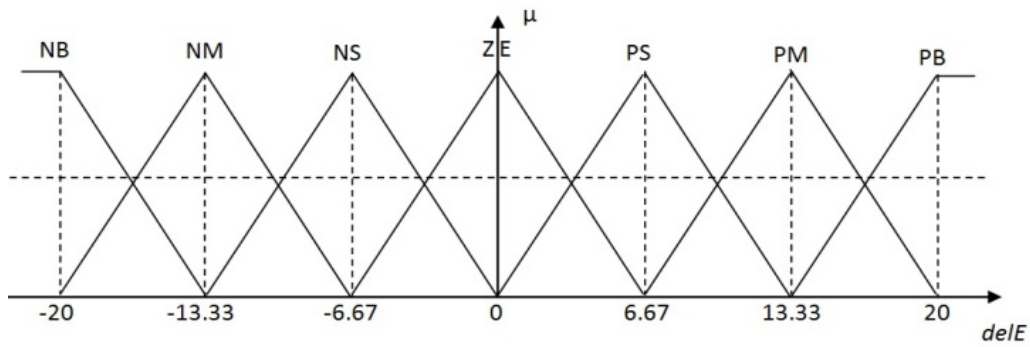


Fig. 6. Membership Function of $delE$.

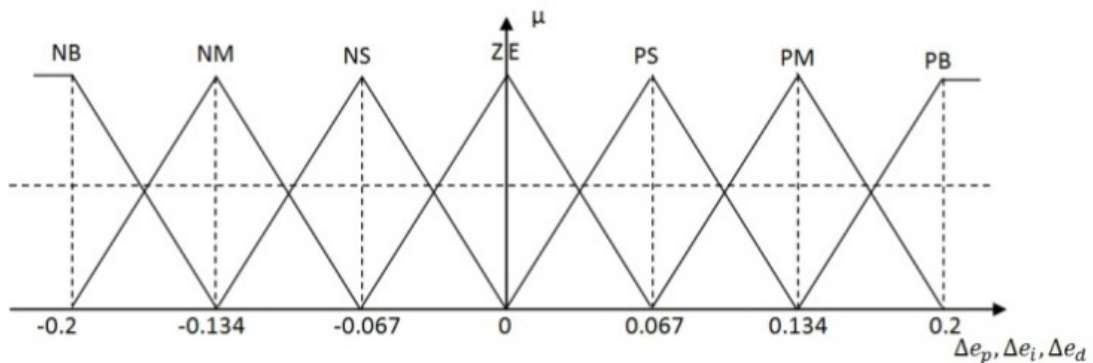


Fig. 7. Membership Function of Output.

Meanwhile, the FIS for each $\Delta e_p(t)$, $\Delta e_i(t)$, $\Delta e_d(t)$ are set based on a few rules [4, 5]:

- 1) If $|E|$ is larger, then Δe_p should be larger meanwhile Δe_i should be limited to 0 or smaller to avoid the system appearing large overshoot.
- 2) If $|E|$ is moderate, then Δe_p and Δe_i should be moderate.
- 3) If $|E|$ is smaller, then Δe_p should be smaller and Δe_i should be larger for better steady state performance.

Meanwhile for $delE$, usually Δe_d will be changed for faster or slower response of controller but flow response is a fastest response than other applications, so Δe_d is left to be zero to avoid unstable response of controller.

4.2. Designing ANFIS

For the ANFIS controller development, the author had used ANFIS Editor Graphical User Interface (GUI) which can be access by using *anfisedit* command (Fig. 8). The controller has two inputs and one output. The inputs are from Set Point and Error of the process while the output is the controller response. Data training was obtained based on the PI controller performance. In order to make sure the ANFIS controller can operate accurately, the training data set which is obtained from the PID controller should possess sufficient operational range including the maximum and minimum values for input-output variables [17]. In addition, to make sure the ANFIS controller can be controlled with various inputs, the data training was obtained by setting the input of PID controller to be random input and the operating range between 15 l/min to 45 l/min.

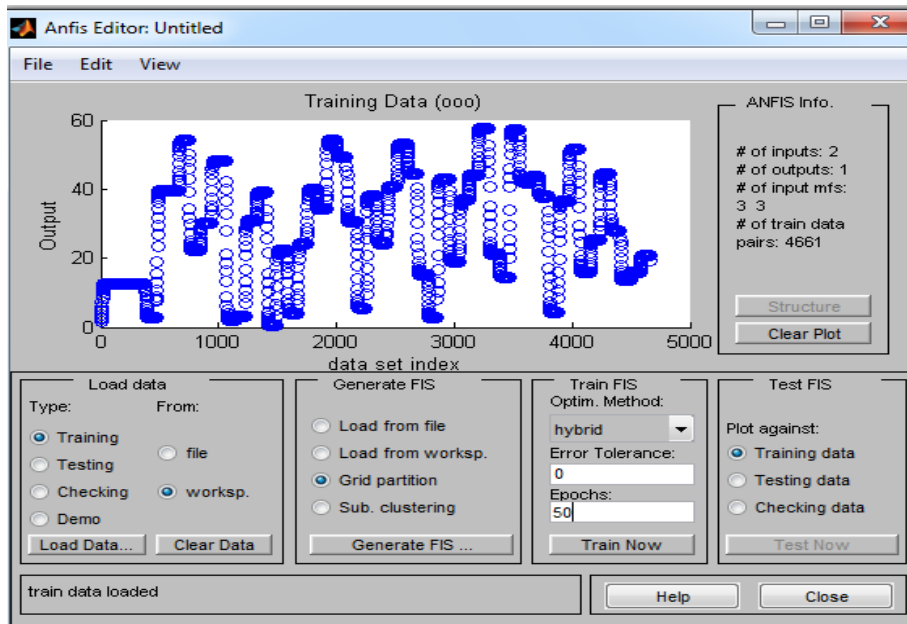


Fig. 8. ANFIS Editor GUI.

The steps for designing the ANFIS controller are as follow:

1. Generated training data set is loaded to ANFIS Editor from workspace.
2. The Fuzzy Inference System (FIS) was generated based on Grid partition. The parameters for both inputs are as below:
 - Number of MF = 9 for each input
 - Input MF type = Triangle
 - Output MF type = Linear
3. For the training process:
 - Optimization method = hybrid
 - Error tolerance = 0
 - Epochs = 50

Since there is no standard method to find the optimum value for epochs, a trial and error procedure was used.

The developed AFPIDC and ANFIS will be implemented to control the operation of the pilot plant and the performances for those controllers will be compared with PID controller. The implementation is done via two data acquisition card USB1208FS connected between desktop to Control Valve as output and from Orifice Flow Meter as input. The flow control operation will be done by using MATLAB/Simulink with Data Acquisition, Fuzzy Logic and PID Controller toolboxes [6].

Simulink model circuit for the implementation of each controller (PID, FLC and AFPIDC) is illustrated in Fig. 9. Some of the features of the Simulink model used for are:

- a) DCS- like HMI feature with scopes to show real time data for PV, MV and SP
- b) User friendly approach where the operator can input the set point and change from auto to manual easily
- c) Engineering Units for SP and PV are used in liter per min and MV with percentage of opening
- d) Data can be collected over a very long period of time and saved to the workspace or file.
- e) Gaussian filter used to filter noise in the signal obtained from Flow Meter.

- f) For FLC and AFPIDC, the controller includes a memory block to act as an accumulator that adds up the controller output over time.

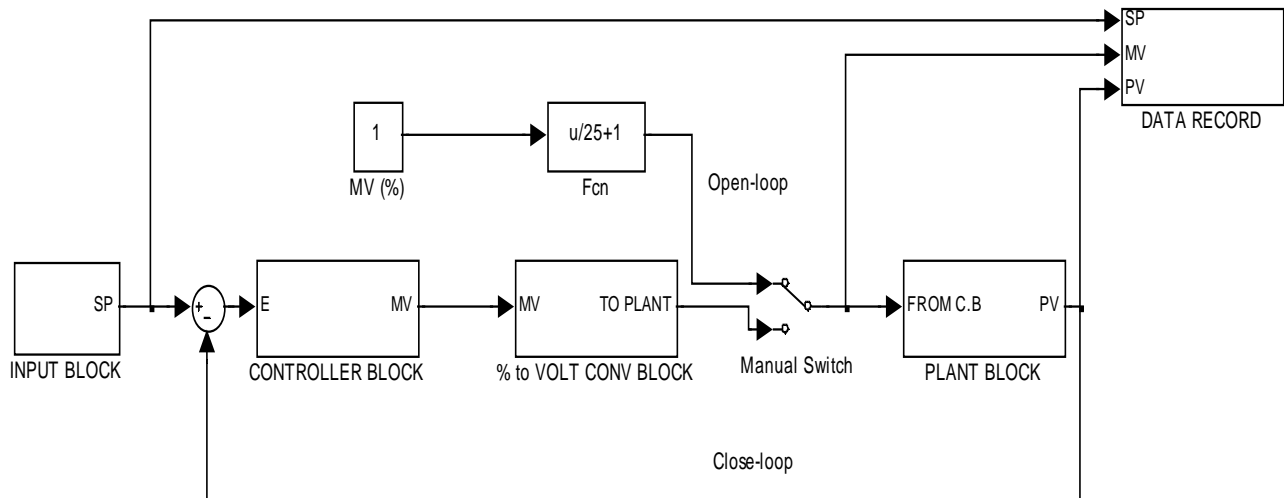


Fig. 9. Simulink Model for Controller Implementation.

5. Result and Analysis

5.1. Controllers' Response

To evaluate the robustness of the controller, all controllers have been subjected to random set point changes using the “uniform random number” block in Simulink. Since the operating range of the plant is set from 15 *l/min* to 45 *l/min*. with an interval of 20 seconds for PID and AFPIDC while 3 seconds for ANFIS. This shall provide the controller sample time to settle to steady state with each set point changes. Below are the results for three controllers for random set point changes.

From the result of each controller's response due to random set point change, it is obvious that the best controller is ANFIS followed by AFPIDC and PID controller. Generally, hybrid controller response will provide faster response in terms of rise time and settling time with zero steady state error is better than PID controller (Fig.10). So, by using hybrid controllers such as AFPIDC and ANFIS, it can be seen that it provides better control performance than PID controller as seen in Fig. 11 and Fig. 12.

A more detailed study of the control performance is explained using the step change set point as input. All three of the controllers are subjected to the same conditions and a set point change from 25 *l/min* to 40 *l/min* is introduced to the system.

From the results shown in Fig. 13, 14 and 15, the control performances show that the hybrid controllers show better performance than PID controller. This is due to the AFPIDC and ANFIS provide better settling time, smaller integral of absolute error (IAE), smaller MV overshoot. The summary of the result analysis for three controllers (PID, AFPIDC and ANFIS) is shown in Table 3.

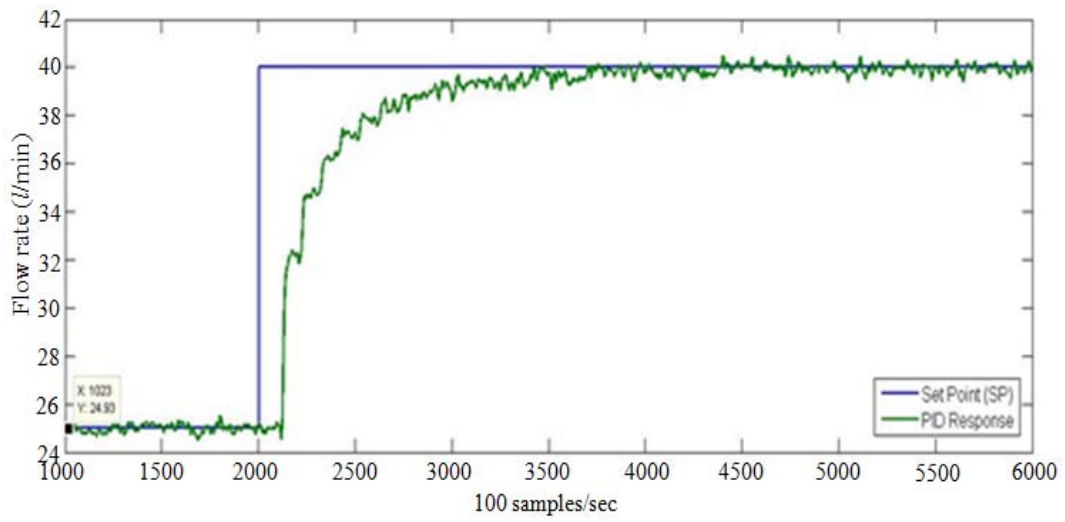


Fig. 10. PID Response to Random Set Point Input.

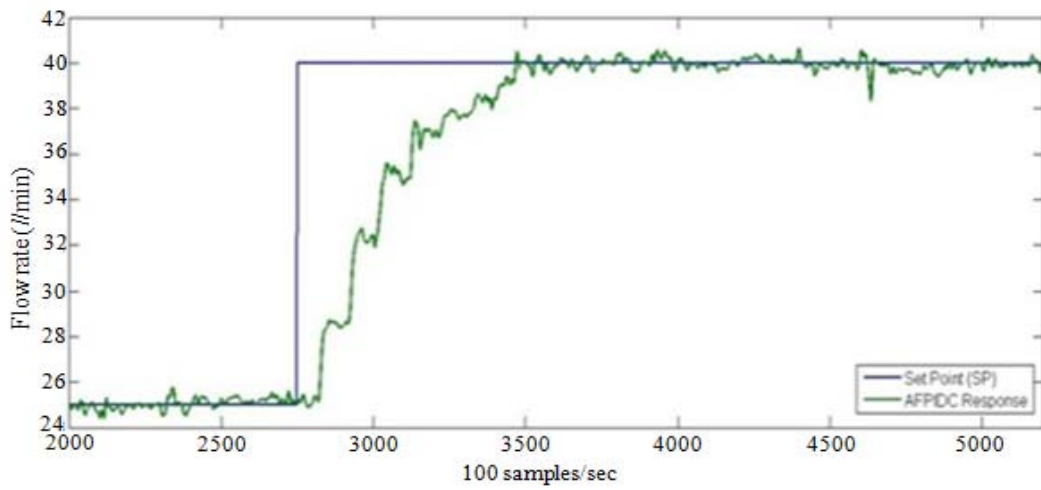


Fig. 11. AFPIDC Response to Random Set Point Input.

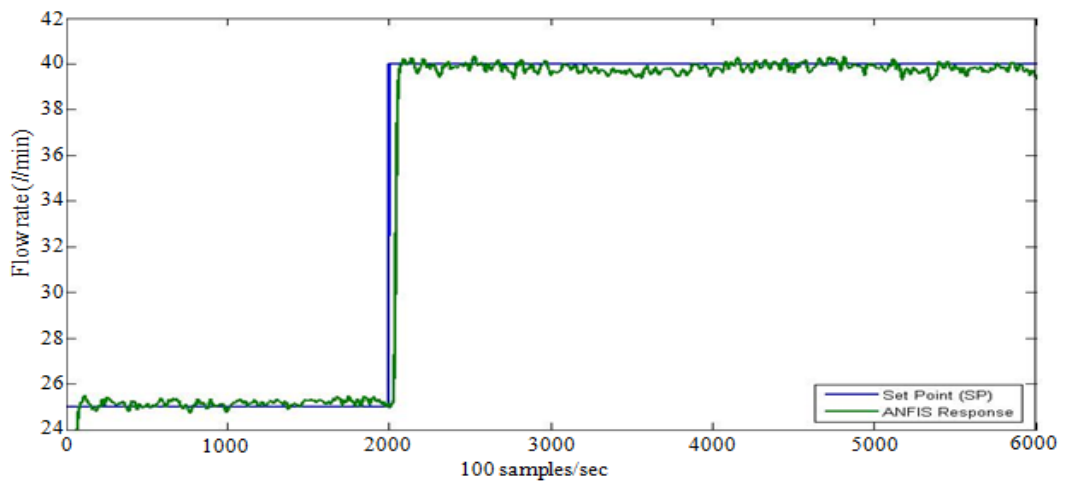


Fig. 12. ANFIS Response to Random Set Point Input.

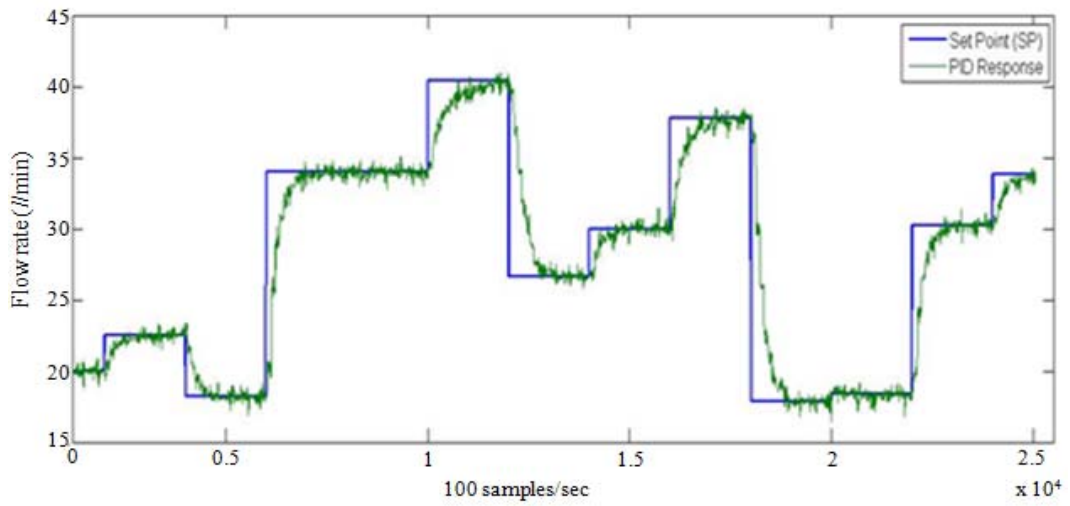


Fig. 13. PID Response to Step Input.

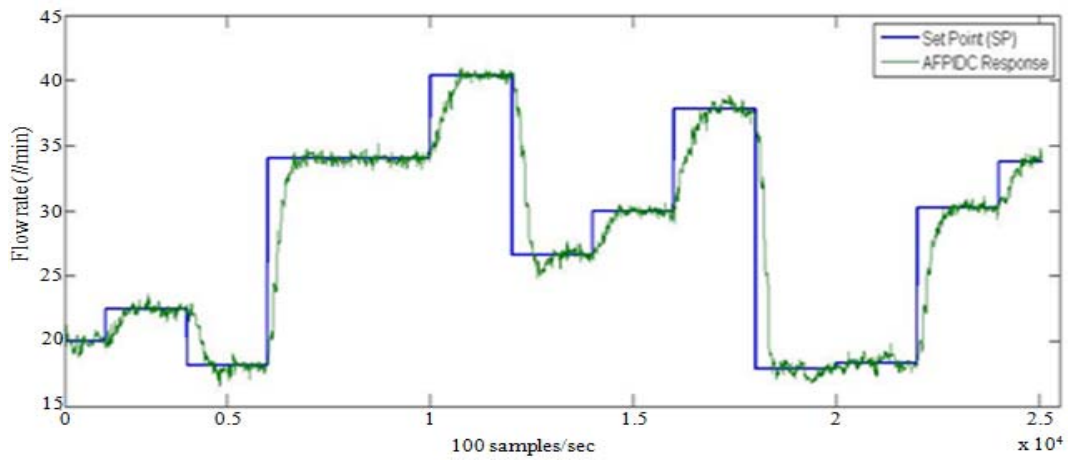


Fig. 14. AFPIDC Response to Step Input.

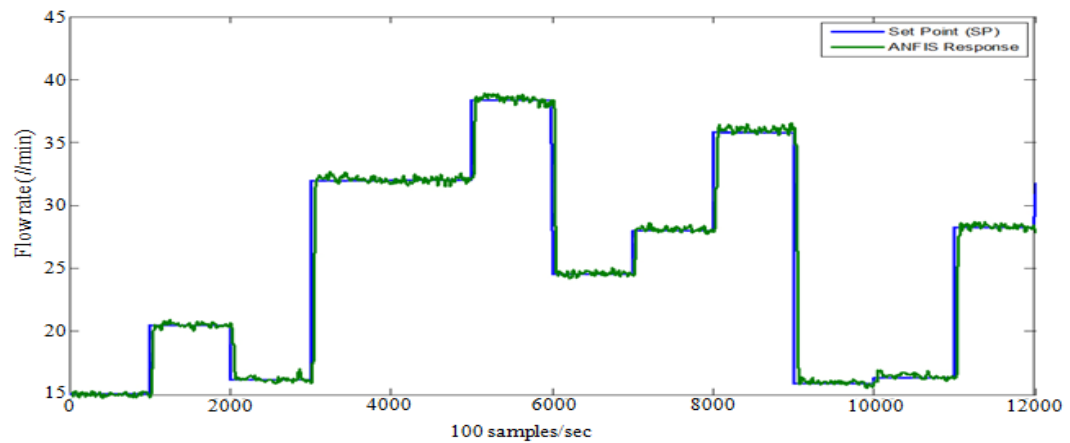


Fig. 15. ANFIS Response to Step Input.

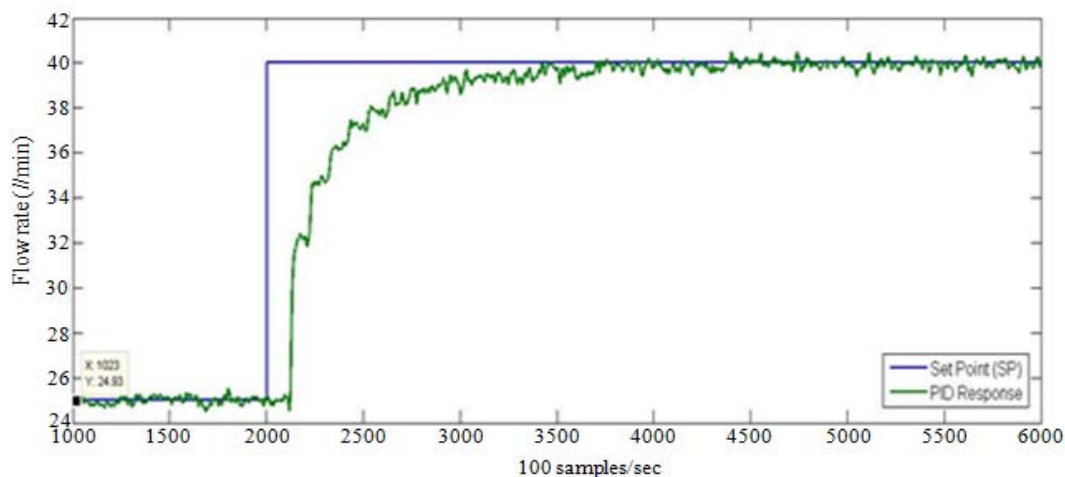
Table 3. Controller Performance Comparison.

Control Performance	PID	AFPIDC	ANFIS
IAE	Intermediate	Small	Very Small
Rise Time	14.21 s	7.17 s	0.68 s
Settling Time	14.21 s	7.17 s	0.68 s
Decay Ratio	0.00	0.00	0.00
Steady State Error	Acceptable	Acceptable	Acceptable
% Overshoot	0.00 %	0.00 %	0.00 %

5.2. Bubble Noise Effect

Based on previous investigation [10], one of the common disturbances that affect the flow meter is the bubbling effect. Bubble noise is caused by the superposition of single pulses generated by individual bubbles which are randomly distributed in the liquid [11]. Bubble is produced by inserting air in the water inside the tank using a tube. Some bubbles will escape through the pipe lines and cause disturbances to the flow meter measurement. The output of the flow meter will fluctuate rapidly that affect the controller performances.

Fig. 16, 17 and 18 show the controller performances under bubbling noise disturbances. AFPIDC and ANFIS response exhibits no overshoot and provides faster response than PID controller under bubbling noise disturbances based on results in Table 4. The rise time and settling time for PID controller has increased for 2.7 seconds meanwhile for AFPIDC; they have only increased 0.64 seconds and for ANFIS it increase 0.12 seconds. Thus, AFPIDC and ANFIS provide stable controller response than PID controller with disturbances in the process plant.

**Fig. 16.** Bubble created at the bottom of the tank.

6. Conclusion and Recommendation

Hybrid controllers such as AFPIDC and ANFIS are combination between two types of different controllers. By using this approach, hybrid controller is capable to overcome drawbacks that exist within a controller. Adaptive Fuzzy PID Controller (AFPIDC) uses the Fuzzy Logic reasoning to automatically tune the PID gain so that the controller will have better control performances than the conventional PID controller. While for ANFIS, ANN is used as a tuning method for the Fuzzy Logic

construction. With the learning ability, ANN will tune the Fuzzy Logic membership function based on the applied input-output training data set. With the combination between Fuzzy Logic and ANN, ANFIS show better control performances in term of faster response and stability.

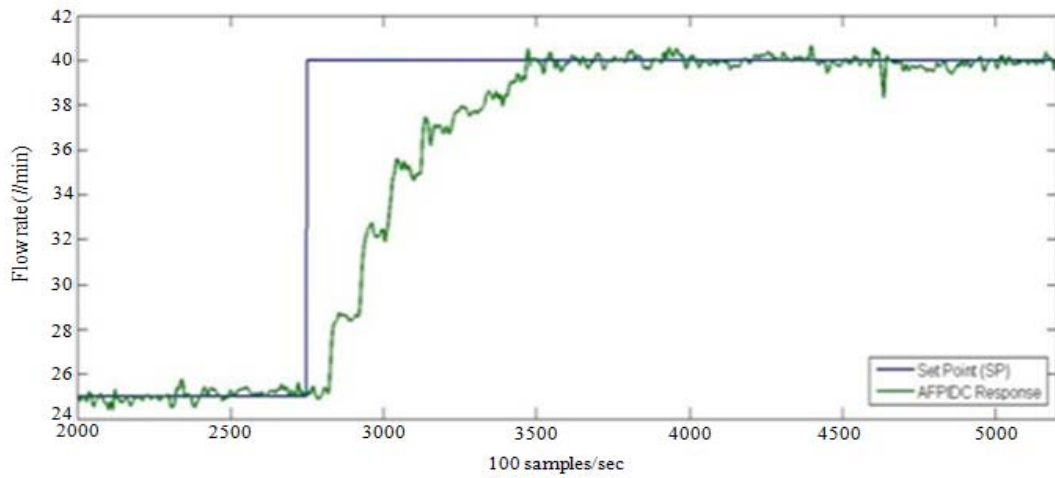


Fig. 17. PID and AFPIDC Response with Bubbling effect.

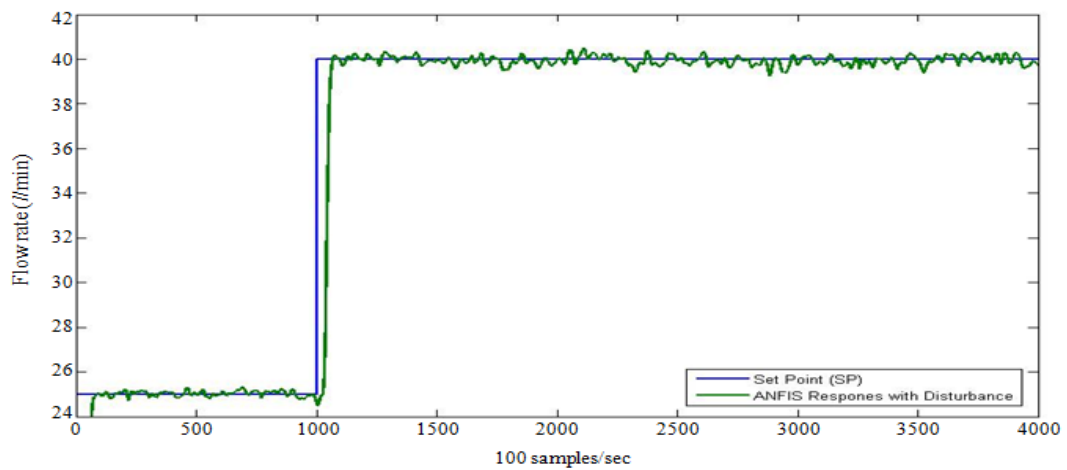


Fig. 18. ANFIS Response with Bubbling Effect.

Table 4. Controller Performance with Disturbance.

Control Performance	PID	AFPIDC	ANFIS
IAE	Intermediate	Small	Very Small
Rise Time	16.90 s	7.81 s	0.8 s
Settling Time	16.90 s	7.81 s	0.8 s
Decay Ratio	0.00	0.00	0.00
Steady State Error	Acceptable	Acceptable	Acceptable
% Overshoot	0.00 %	0.00 %	0.00 %

The objectives of this project which are to develop hybrid controllers such as AFPIDC and ANFIS, then implement onto the Mobile Pilot Plant for flow control application, and develop a DCS-HMI system have been achieved successfully. The most important part is that it has also managed to compare the controller performances between PID, AFPIC and ANFIS controllers.

As for further recommendation, other types of intelligent controllers such as PID- Fuzzy with Generic Algorithm (GA) and Model Predictive Control (MPC) can be implemented onto the pilot plant in order to compare the control performances.

References

- [1]. Thomas E. Marlin, *Process Control: Designing Processes and Control Systems for Dynamic Response*, 2nd Edition, *McGraw Hill Publications*, 2000.
- [2]. S. Bennet, Development of the PID Controller, *IEEE Control System Magazine*, Vol. 13, 1993, pp. 58 – 65.
- [3]. Tang, K. S., Kim Fung Man, Guanrong Chen, Kwong, S., An optimal fuzzy PID controller, *Industrial Electronics*, Vol. 48, 2001, pp. 757-765.
- [4]. Yuanhui Yang, Wailing Yang, Mingchun Wu, Qiwen Yang, Yuncan Xue, A New Type of Adaptive Fuzzy PID Controller, in *Proc. of the 8th World Congress on Intelligent Control and Automation (WCICA)*, 2010, pp. 5306-5310.
- [5]. Ding Chengsong, Cao Lijun, Self Adaptive Fuzzy PID Controller for Water Supply System, *International Conference on Measuring Technology and Mechatronics Automation*, 2010 pp, 311 – 314.
- [6]. Ian S. Shaw, *Fuzzy Control of Industrial Systems: Theory and Applications*, *Kluwer Academic Publishers*, 1998, pp. 135.
- [7]. K. J Aström, Intelligent Tuning, in *Adaptive Systems in Control and Signal Processing*, L. Dugard, M'Saad and I. D Landau, Eds, *Pergamon*, Oxford, U. K.: 1992, pp. 360- 370.
- [8]. K. J Aström, T Hägglund, C. C. Hang and W. K. Ho, Automatic Tuning and Adaption for PID Controllers- A survey, in *Adaptive System in Control and Signal Processing*, L. Dugard, M'Saad and I. D Landau, Eds, *Pergamon*, Oxford, U. K., 1992, pp. 371 – 376.
- [9]. G. Chen, Conventional and Fuzzy PID Controllers: An Overview, *Int. J. Intell. Control Sys.*, Vol. 1, 1996, pp. 235-246.
- [10]. Pathmanathan, E., Ibrahim, R., Development and Implementation of Fuzzy Logic Controller for Flow Control Application, in *Proc. of the International Conference on Intelligent and Advanced Systems (ICIAS' 2010)*, Vol., No., 15-17 June 2010, pp. 1-6.
- [11]. Fuge R., Horst. L., Bubble Noise at Magnetic Flow Meters, *Nuclear Engineering and Design*, Vol. 49-3, September 1978, pp. 205-212.
- [12]. Bonisson, P. P, *Adaptive Neuro-Fuzzy Inference Systems (ANFIS): Analysis and Applications*, 2002, Available online at: <http://homepages.rpi.edu/~bonisp/fuzzy-course/Papers-pdf/anfis.rpi04.pdf>
- [13]. D. Nauck, F. Klawonn and R. Kruse, Combining Neural Networks and Fuzzy Controllers, *Fuzzy Logic in Artificial Intelligence*, *Springer-Verlag*, Berlin, 1993.
- [14]. Dr. Bob John, *Adaptive Network Based Fuzzy Inference Systems (ANFIS)*, Available online at <http://www.tech.dmu.ac.uk/~hseker/ANFISnotes.doc>
- [15]. Piero P. Bonissone, *Adaptive Neural-Fuzzy Inference Systems (ANFIS): Analysis and Applications*, 2002, Available online at <http://www.rpi.edu/~bonisp/fuzzy-course/Papers-pdf/anfis.rpi04.pdf>
- [16]. Fuge R. Horst. L., Bubble Noise at magnetic Flow meters, *Nuclear Engineering and Design*, Vol. 49-3, September 1978, pp. 205-212.
- [17]. R. Sivakumar, C. Sahana and P. A. Savitha, Design of ANFIS based estimation and control for MIMO Systems, Available online at http://www.ijera.com/papers/Vol2_issue3/RA2328032809.pdf
- [18]. T. P. Mote, Dr. S. Lokhande, Temperature control system using ANFIS, Available online at: <http://www.ijscce.org/attachments/File/v2i1/A0407022112.pdf>



International Frequency Sensor Association Publishing Call for Books Proposals

Sensors, MEMS, Measuring instrumentation, etc.



Benefits and rewards of being an IFSA author:

1

Royalties

Today IFSA offers most high royalty in the world: you will receive 50 % of each book sold in comparison with 8-11 % from other publishers, and get payment on monthly basis compared with other publishers' yearly basis.

2

Quick Publication

IFSA recognizes the value to our customers of timely information, so we produce your book quickly: 2 months publishing schedule compared with other publishers' 5-18-month schedule.

3

The Best Targeted Marketing and Promotion

As a leading online publisher in sensors related fields, IFSA and its Sensors Web Portal has a great expertise and experience to market and promote your book worldwide. An extensive marketing plan will be developed for each new book, including intensive promotions in IFSA's media: journal, magazine, newsletter and online bookstore at Sensors Web Portal.

4

Published Format: printable pdf (Acrobat).

When you publish with IFSA your book will never go out of print and can be delivered to customers in a few minutes.

You are invited kindly to share in the benefits of being an IFSA author and to submit your book proposal or/and a sample chapter for review by e-mail to editor@sensorsportal.com. These proposals may include technical references, application engineering handbooks, monographs, guides and textbooks. Also edited survey books, state-of-the-art or state-of-the-technology, are of interest to us. For more detail please visit: http://www.sensorsportal.com/HTML/IFSA_Publishing.htm



International Frequency Sensor Association (IFSA) Publishing

Digital Sensors and Sensor Systems: Practical Design

Sergey Y. Yurish



Formats: printable pdf (Acrobat) and print (hardcover), 419 pages

ISBN: 978-84-616-0652-8,
e-ISBN: 978-84-615-6957-1

The goal of this book is to help the practitioners achieve the best metrological and technical performances of digital sensors and sensor systems at low cost, and significantly to reduce time-to-market. It should be also useful for students, lectures and professors to provide a solid background of the novel concepts and design approach.

Book features include:

- Each of chapter can be used independently and contains its own detailed list of references
- Easy-to-repeat experiments
- Practical orientation
- Dozens examples of various complete sensors and sensor systems for physical and chemical, electrical and non-electrical values
- Detailed description of technology driven and coming alternative to the ADC a frequency (time)-to-digital conversion

Digital Sensors and Sensor Systems: Practical Design will greatly benefit undergraduate and at PhD students, engineers, scientists and researchers in both industry and academia. It is especially suited as a reference guide for practitioners, working for Original Equipment Manufacturers (OEM) electronics market (electronics/hardware), sensor industry, and using commercial-off-the-shelf components

http://sensorsportal.com/HTML/BOOKSTORE/Digital_Sensors.htm

Guide for Contributors

Aims and Scope

Sensors & Transducers Journal (ISSN 1726-5479) provides an advanced forum for the science and technology of physical, chemical sensors and biosensors. It publishes state-of-the-art reviews, regular research and application specific papers, short notes, letters to Editor and sensors related books reviews as well as academic, practical and commercial information of interest to its readership. Because of it is a peer reviewed international journal, papers rapidly published in *Sensors & Transducers Journal* will receive a very high publicity. The journal is published monthly as twelve issues per year by International Frequency Sensor Association (IFSA). In addition, some special sponsored and conference issues published annually. *Sensors & Transducers Journal* is indexed and abstracted very quickly by Chemical Abstracts, IndexCopernicus Journals Master List, Open J-Gate, Google Scholar, etc. Since 2011 the journal is covered and indexed (including a Scopus, Embase, Engineering Village and Reaxys) in Elsevier products.

Topics Covered

Contributions are invited on all aspects of research, development and application of the science and technology of sensors, transducers and sensor instrumentations. Topics include, but are not restricted to:

- Physical, chemical and biosensors;
- Digital, frequency, period, duty-cycle, time interval, PWM, pulse number output sensors and transducers;
- Theory, principles, effects, design, standardization and modeling;
- Smart sensors and systems;
- Sensor instrumentation;
- Virtual instruments;
- Sensors interfaces, buses and networks;
- Signal processing;
- Frequency (period, duty-cycle)-to-digital converters, ADC;
- Technologies and materials;
- Nanosensors;
- Microsystems;
- Applications.

Submission of papers

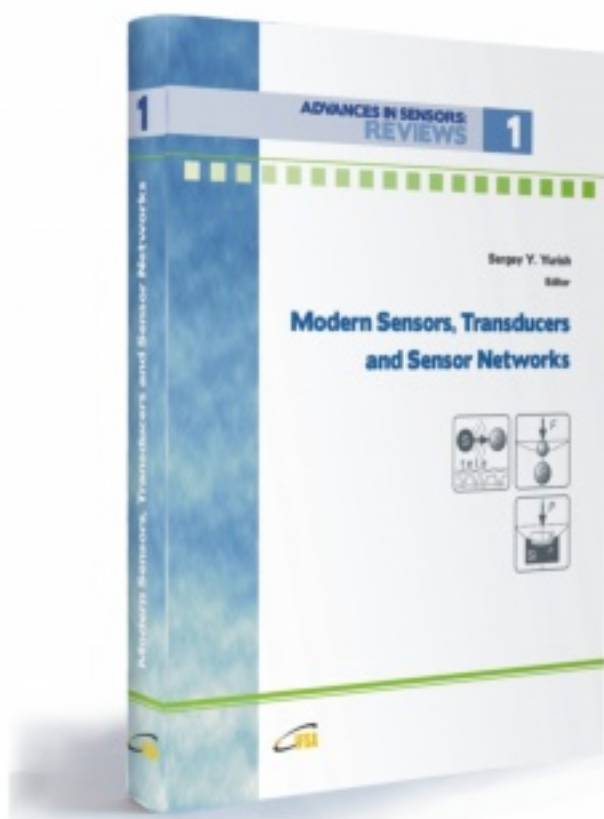
Articles should be written in English. Authors are invited to submit by e-mail editor@sensorsportal.com 8-14 pages article (including abstract, illustrations (color or grayscale), photos and references) in both: MS Word (doc) and Acrobat (pdf) formats. Detailed preparation instructions, paper example and template of manuscript are available from the journal's webpage: <http://www.sensorsportal.com/HTML/DIGEST/Submission.htm> Authors must follow the instructions strictly when submitting their manuscripts.

Advertising Information

Advertising orders and enquires may be sent to sales@sensorsportal.com Please download also our media kit: http://www.sensorsportal.com/DOWNLOADS/Media_Kit_2012.pdf

Sergey Y. Yurish
Editor

Modern Sensors, Transducers and Sensor Networks



Modern Sensors, Transducers and Sensor Networks is the first book from the Advances in Sensors: Reviews book Series contains dozen collected sensor related state-of-the-art reviews written by 31 internationally recognized experts from academia and industry.

Built upon the series Advances in Sensors: Reviews - a premier sensor review source, the *Modern Sensors, Transducers and Sensor Networks* presents an overview of highlights in the field. Coverage includes current developments in sensing nanomaterials, technologies, MEMS sensor design, synthesis, modeling and applications of sensors, transducers and wireless sensor networks, signal detection and advanced signal processing, as well as new sensing principles and methods of measurements.

Modern Sensors, Transducers and Sensor Networks is intended for anyone who wants to cover a comprehensive range of topics in the field of sensors paradigms and developments. It provides guidance for technology solution developers from academia, research institutions, and industry, providing them with a broader perspective of sensor science and industry.

Order online:

http://sensorsportal.com/HTML/BOOKSTORE/Advance_in_Sensors.htm



www.sensorsportal.com