Intell Ind Syst (2016) 2:283–285
DOI 10.1007/s40903-016-0066-5

EDITORS PREFACE TO ISSUE

Journal of Intelligent Industrial Systems

Preface to vol. 2 no. 4

G. Rigatos[1] · P. Siano[2]

Published online: 29 November 2016

The articles included in vol.2, no. 4 of the Journal of Intelligent Industrial Systems can be classified in three main categories: (i) approaches to improved management of electric power systems, (ii) control methods for electric power systems (iii) control methods for complex electromechanical systems. In the first class of articles, that is improved management of electric power systems, one can distinguish a computational approach for solving the multi-objective optimization problem of the configuration of the power distribution grid. Moreover, in this thematic area belongs an article on the development of an improved home energy management system, showing that electric home appliances can be operated in an energy efficient manner despite the processing of ambiguous sensor measurements. In the second class of articles, that is control of electric power systems, one can distinguish first a vector control method for voltage inverters addressed to active power filters. The method contributes to the compensation of distortions in the grid's voltage and thus it allows for improvement of the quality of the provided electric power. In the same class of articles a manuscript on differential flatness theory-based control of DC–DC converters is included. The method allows for more efficient conversion and exploitation of the power produced by photovoltaic units. In the third class of articles, that is control of complex electromechanical systems, one can distinguish first a method for differential flatness theory-based control of chaotic dynamical systems. As a case study, control and stabilization of the Lorenz chaotic oscillator is presented. In the same class of articles one can assign a manuscript presenting results on adaptive neurofuzzy (model-free) control of the turbocharged diesel engine. The presented method is based again on differential flatness theory and achieves control of diesel engines without need for prior knowledge about the its dynamic model.

In article *Multi-objective distribution network reconfiguration based on Pareto-front making* by A. Mazza, G. Chicco, A. Russo and E. Virjoghe the problem of multi-objective optimization of the power distribution grid through the application of evolutionary programming is treated. Taking into account the power distribution system's losses together with other objectives, among which reliability indicators, one arrives at the formulation of the associated multi-objective optimization problem. Pareto front analysis enables the grid's operator to handle conflicting and even non-commensurable objectives without needing the use of additional hypotheses. The paper presents new results on the computation of the Pareto front as part of the solution of the multi-objective optimization problem for distribution network reconfiguration. Starting from previous results in which genetic algorithms were effectively adopted to find the best-known Pareto front, a version of the multi-objective binary particle swarm optimization, customized for distribution network reconfiguration, has been developed by exploiting the internal ranking of the solutions and the network topology. Furthermore, the Pareto front mismatch metric has been generalized so as to be used in large systems for which only the best-known Pareto front is found. Applications to a test network and to a real urban distribution network are discussed, showing the consistent superiority of the customized multi-objective binary

✉ G. Rigatos
grigat@ieee.org

P. Siano
psiano@unisa.it

[1] Unit of Industrial Automation, Industrial Systems Institute, 26504 Rion Patras, Greece

[2] Department of Industrial Engineering, University of Salerno, 84084 Fisciano, Italy

particle swarm optimization with respect to (i) the application of genetic algorithms and (ii) a more classical version of the particle swarm optimization method.

In article *Enabling residential demand response applications with a Zigbee-based load controller design,* by A. Saha, M. Kuzlu, M. Pipattanasomporn and S. Rahmanthe, a topic of home appliances power management is treated (e.g. those used for heating, air/conditioning and ventilation) through the processing of ambiguous (delayed) sensor measurements. Home energy management (HEM) solutions rely on either smart appliances or on connecting traditional appliances into smart outlet/smart plugs which can communicate with the central HEM server. Conventional non-communicating power intensive loads are usually hard-wired directly to the supply panel of the house (e.g. water heaters and clothes dryers), therefore it is difficult for them to be part of an HEM system. This paper describes the design and implementation of a microcontroller and ZigBee-based load controller system that allows for the latter class of loads to be controlled by an HEM system. The proposed system consists of four load controllers (LCs) that monitor and control four power-intensive household loads, and one communication controller (CC) that acts as a communication medium between LCs and a central HEM unit. The CC and all the LCs are packaged into one load controller box that can be placed beside the main circuit panel of the house and the wirings to the power-intensive loads are routed through the LCs. In the presented approach, it is shown that within the box, the LCs and the CC communicate via hard-wired serial peripheral interface (SPI). The CC then communicates with the HEM system via ZigBee. The proposed system is expected to offer a cost-effective method to enable traditional hard-wired power intensive loads to participate in an HEM system. Moreover, it is demonstrated that in the proposed HEM method it is possible to compensate for time delays in the sensor readings after processing these measurements with a robust control scheme.

In article *Space-vector hysteresis control with constant switching frequency for three-level shunt active power filter,* by A. Fereidouni and M. Masoum a new constant-frequency space-vector hysteresis current control (CF-SVHCC) technique is proposed for three-level neutral-point diode-clamped (TL-NPC) inverters. The method targets shunt active power filter (SAPF) applications when applied to three-phase isolated neutral point (INP) systems. The proposed technique is developed based on two recognized modulation methods, space-vector pulsewidth modulation (SVPWM) and adaptive hysteresis-band current control (AHCC). The proposed technique consists of two alternating adaptive hysteresis-band strategies around the error-current vector in the $\alpha\beta$ stationary reference frame (SRF). The first approach is designed with the purpose of utilizing the medium- and large-voltage vectors of the TL-NPC inverter to keep the error-current vector within the adaptive hysteresis boundary. The second approach is designed according to the small-voltage vectors of the TL-NPC inverter to balance its neutral point voltage. The main part of this proposed technique is a supervisory controller that operates in SRF to effectively avoid inter-phase dependency. This smart controller systematically uses the zero-voltage vectors and the nonzero-voltage vectors associated with the alternating adaptive hysteresis-band approaches in order to prevent high switching frequency and maintain the switching frequency constant in INP systems, respectively. The performance of the proposed hysteresis current control method for voltage inverters is validated by extensive simulation studies for both steady-state and transient conditions.

In article *Control of DC-DC converter and DC motor dynamics using differential flatness theory,* by G. Rigaatos, P. Siano, P. Wira and M. Sayed-Mouchaweh a differential flatness theory-based method is proposed for nonlinear control of the dynamical system that is formed by a DC–DC converter and a DC motor. The method allows for improved exploitation and conversion of the energy produced by photovoltaic units. First, it is proven that the aforementioned system is differentially flat one, which means that all its state vector elements and its control inputs can be expressed as differential functions of primary state vari-ables which are defined to be the systems flat outputs. By exploiting the differential flatness properties of the model its transformation to a linearized canonical (Brunovsky) form becomes possible. For the latter description of the system one can design a stabilizing feedback controller. Moreover, estimation of the nonmeasurable state vector elements of the system is achieved by applying a new nonlinear Filtering method which is known as Derivative-free nonlinear Kalman Filter. This filter consists of the Kalman Filter recursion applied on the linearized equivalent model of the system and of an inverse transformation that is based on differential flatness theory and which enables to obtain estimates of the initial nonlinear state-space model. Moreover, to compensate for parametric uncertainties and external perturbations the filter is redesigned as a disturbance observer. By estimating the perturbation inputs that affect the joint model of the DC–DC converter and of the DC motor their compensation becomes possible. The efficiency of the proposed control scheme is further confirmed through simulation experiments.

In article *Flatness-based adaptive neurofuzzy control of chaotic dynamical systems* by G. Rigatos and P. Siano a solution is proposed to the problem of control of nonlinear chaotic dynamical systems. The method is based on differential flatness theory and on adaptive fuzzy control. An adaptive fuzzy controller is designed for chaotic dynamical systems, under the constraint that the systems model is unknown. The control algorithm aims at satisfying the H-infinity tracking performance criterion, which means that the influence of the modeling errors and the external disturbances on the tracking error is attenuated to an arbitrary desirable level.

After transforming the chaotic system's model into a linear form, the resulting control inputs are shown to contain nonlinear elements which depend on the system's parameters. The nonlinear terms which appear in the control inputs are approximated with the use of neuro-fuzzy networks. It is shown that a suitable learning law can be defined for the aforementioned neuro-fuzzy approximators so as to preserve the closed-loop system stability. With the use of Lyapunov stability analysis it is proven that the proposed adaptive fuzzy control scheme results in H-infinity tracking performance. The efficiency of the considered adaptive fuzzy controller is checked through simulation experiments, using as case study the Lorenz chaotic oscillator.

In article *A differential flatness theory approach to embedded adaptive control of turbocharged diesel engines* by G. Rigatos, P. Siano and I. Arsie, the use of efficient embedded control systems in the transportation industry and particularly in turbocharged Diesel engines is analyzed. The solution of this problem requires the programming of elaborated nonlinear control and filtering methods. To this end, nonlinear control for turbocharged Diesel engines is developed with the use of Differential flatness theory and adaptive fuzzy control. It is shown that the dynamic model of the turbocharged Diesel engine is differentially flat and admits dynamic feedback linearization. It is also shown that the dynamic model can be written in the linear Brunovsky canonical form for which a state feedback controller can be easily designed. To compensate for modeling errors and external disturbances an adaptive fuzzy control scheme is implemented making use of the transformed dynamical system of the diesel engine that is obtained through the application of differential flatness theory. The control algorithm aims at satisfying the H-infinity tracking performance criterion, which means that the influence of the modeling errors and the external disturbances on the tracking error is attenuated to an arbitrary desirable level. After transforming the MIMO diesel engine system into the canonical form, the resulting control inputs are shown to contain nonlinear elements which depend on the system's parameters. The nonlinear terms which appear in the control inputs are approximated with the use of neuro-fuzzy networks. Moreover, since only the system's output is measurable the complete state vector has to be reconstructed with the use of a state observer. It is shown that a suitable learning law can be defined for the aforementioned neuro-fuzzy approximators so as to preserve the closed-loop system stability. With the use of Lyapunov stability analysis it is proven that the proposed observer-based adap-tive fuzzy control scheme results in H-infinity tracking performance.

Through the aforementioned six articles the present issue of the journal of Intelligent Industrial Systems achieves to show significant advancements in major areas of industrial systems, that is (i) optimized management of electric power systems, (ii) nonlinear control of electric power systems and (iii) nonlinear control of complex electromechanical systems. The results and findings of this issue confirm that management and control of industrial systems are non-trivial problems which have to be treated with elaborated computational and analytical methods. To cope efficiently with multi-objective optimization problems met in the power distribution grid there is need to employ advanced evolutionary algorithms. To compensate for imprecision and time-delays in the sensors of home energy management systems robust control methods have to be considered. To annihilate distortions in the power grid's voltage, active power filters have to be used functioning under elaborated nonlinear control schemes. To convert and exploit the energy produced by photovoltaics nonlinear control methods of proven precision and stability have to be applied. To stabilize chaotic dynamics in electromechanical systems there is need to implement elaborated global linearization-based control methods. Finally, for the functioning of diesel engines under given specifications the use of nonlinear control methods of proven stability is again indispensable. The above confirm the challenges and perspectives of research in intelligent industrial systems and designate areas where significant findings should ne anticipated in the forthcoming years.