Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
February 2015, Volume 40, Issue 2, pp 551-558

A New Highly Accurate CMOS Current-Mode Four-Quadrant Multiplier

- Munir A. Al-Absi , Ibrahim A. As-Sabban

Abstract:

A new CMOS current-mode four-quadrant analog multiplier is presented. The design is based on the square-difference approach using short-channel MOSFETs operating in saturation region and a rectifier. The squaring circuit used is free of error due to carrier mobility reduction and hence an accurate multiplier is achieved. Tanner T-spice is used to confirm the functionality of the proposed design using 0.18μm TCMS CMOS process technology. Simulation results shows that the relative error is 1.8% and –3dB frequency is 230MHz.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
February 2015, Volume 40, Issue 2, pp 531-549

Multi-area Multi-fuel Economic–Emission Dispatch Using a Generalized Unified Power Flow Controller Under Practical Constraints

- Chintalapudi V. Suresh , S. Sivanagaraju , J. Viswanatha Rao

Abstract:

This paper presents a novel optimization algorithm for the multi-area multi-fuel economic–emission dispatch problem and total power loss objective. The proposed method uses the uniform distribution to determine the control parameters and employs a two-stage initialization process. This enables various objectives to be optimized under practical constraints and device limits. We formulate a realistic generation cost that includes the cost of reactive power generation, shunt power injections, and total power losses, along with the conventional active power generation cost. A novel objective based on the concept of multi-fuel emissions makes the problem more realistic, and a generalized unified power flow controller (GUPFC) is considered. A detailed power injection model is developed for a GUPFC with two series converters, including switching losses of converters. A nondominated sorting methodology and particle swarm optimization algorithm are then used to solve the multi-objective problem on the standard IEEE-30 bus and real-time Indian-124 bus test systems.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Technical Note - Electrical Engineering
March 2015, Volume 40, Issue 3, pp 893-899

Distributed Gradient Descent Localization in Wireless Sensor Networks

- Nuha A. S. Alwan , Alaa S. Mahmood

Abstract:

We propose a distributed gradient descent (GD) localization algorithm in 3D space for wireless sensor networks that employ the push-sum (PS) gossip algorithm to compute sums. Sums and averages constitute building blocks for various signal processing applications including the one under consideration. Our contribution lies in combining vector PS and GD approaches achieving fast convergence, high accuracy and a remarkable robustness against link failures. Comparisons are presented with the centralized counterpart and with similar recent works.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
March 2015, Volume 40, Issue 3, pp 873-882

Convex and Non-convex Heat Curve Parameters Estimation Using Cuckoo Search

- M. R. AlRashidi , K. M. El-Naggar , M. F. AlHajri

Abstract:

Cuckoo search-based algorithm is presented for accurate estimation of thermal power plant heat curve (or fuel cost function) parameters. The fuel cost function of power plant reveals some of its economical characteristics that greatly impact many operational practices. Some of influential factors that affect the input–output characteristics of thermal power plants are ambient operating temperature and aging of generating units. Periodical and accurate extraction of fuel cost function characteristics is very important as it directly affects optimal power flow and economic dispatch calculations which in turn enhances the overall operational and economical practices. Convex and non-convex or smooth and non-smooth models that describe the input–output relationship of thermal units are considered including the one that accounts for the valve loading point. The objective is to minimize the total estimation error using cuckoo search algorithm via proper estimation of fuel cost function parameters. The proposed approach relieves some of the mathematical restrictions typically imposed on system modeling since it does not require convexity nor differentiability like in the case of many conventional estimation techniques. Various study cases are considered in this work to test the performance of the method. Results obtained are compared to those computed using competing estimation methods. Comparison results are in favor of Cuckoo search algorithm in all study cases considered.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
March 2015, Volume 40, Issue 3, pp 883-892

A Nine-Level Inverter with Reduced Number of Components for Open-End Winding Induction Motor

- Sanjiv Kumar , Pramod Agarwal

Abstract:

In this paper, a novel nine-level inverter topology for open-end winding induction motor is proposed. This topology requires less number of components as compared to conventional topologies. The proposed inverter uses two three-phase three-level cascade inverters to generate nine-level in the phase voltage of open-end winding induction motor. An interesting feature of this topology is that in case of failure of any three-level inverter, it can be bypassed and the proposed topology can operate in three-level mode hence reliability of the circuit is improved. Out of two three-level inverters, the inverter which operates at higher DC link voltage switches less as compared to the inverter which operates at a lower DC link voltage, thus switching losses are reduced. A 1.5-kW induction motor is run with the proposed inverter at different modulation indices, and the performance of the drive is evaluated under steady and transient states.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
May 2015, Volume 40, Issue 5, pp 1455-1469

A Novel Strategy-Based Hybrid Binary Artificial Bee Colony Algorithm for Unit Commitment Problem

- Prateek K. Singhal, R. Naresh , Veena Sharma

Abstract:

In this paper, a hybrid approach based on a novel binary artificial bee colony (NBABC) algorithm and local search (LS) is developed to solve the unit commitment problem (UCP). Also, the ramp rate constraints are taken into account in the solution of UCP by performing conventional economic dispatch with modifying unit generating capacities over the entire scheduling time horizon. The proposed NBABC–LS method differs from its counterparts in three main aspects: (i) it utilizes a novel strategy which measures the dissimilarity between two binary strings for generating the new binary strings for UCP; (ii) it uses an intelligent scout bee phase; (iii) A LS module is hybridized with the NBABC algorithm. These modifications result in three major advantages: (i) it avoids the problem of slow and premature convergence and thus does not fall into the local optimum solutions; (ii) it can quickly find the near global optimum solution for UCP; (iii) accuracy and robustness of the solution are achieved. The proposed approach is successfully applied to the test systems up to 100 thermal units over 24-h scheduling time horizon and the real Turkish interconnected power system consisting of eight thermal units over 8-h scheduling time horizon. The obtained results confirm the quality solution in terms of total generation cost compared with the other methods reported in the literature.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
June 2015, Volume 40, Issue 6, pp 1623-1636

Improvement of Handover Performance Based on Bio-Inspired Approach with Received Signal Strength and Mean Opinion Score

- Muhammad Ariff Bin Baharudin , Eiji Kamioka

Abstract:

In mobile communication environments, handover is a very important process to maintain mobile host's connections to the network. Although a lot of researchers have tried to improve the handover performance, little deployment to satisfy the users can be seen in the real network due to the modification costs. In the current age, the existence of network with different radio access technologies has created a heterogeneous environment. Moreover, the mobile hosts available to users are becoming more sophisticated, which opens the opportunity for end-point approaches to alleviate the deployment issues. Furthermore, real-time applications such as VoIP and video conference are delay and quality sensitive, but not much research has considered qualitative requirement. Hence, a suitable technique is needed to alleviate the deployment issues as well as to cope with the stringent requirements of real-time applications. This paper presents a new end-point centric handover approach based on the ant colony probabilistic equation that utilizes the received signal strength and the mean opinion score to trigger the handover. Some simulations were conducted using OMNeT++ to measure the effectiveness of the proposed approach comparing with an existing method, the Endpoint Centric Handover (ECHO). The results show that the proposed approach has better performance compared to the ECHO.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
June 2015, Volume 40, Issue 6, pp 1637-1646

Distance-Based Residual Energy-Efficient Stable Election Protocol for WSNs

- Nitin Mittal , Urvinder Singh

Abstract:

Wireless sensor networks (WSNs) comprise nodes with restricted battery power that are deployed to observe some physical event within the sensor field. Information gathering is typical, but an important operation in several applications of WSNs. It is important to control the sensor network for longer period of time in an energy-efficient manner for gathering information. Hence, it is perpetually fascinating to design protocols that are energy efficient, have prolonged lifetime and can support event-driven applications. This paper proposes a protocol referred to as distance-based residual energy-efficient stable election protocol (DRESEP) that is nearly optimal for event-driven information gathering applications in sensor networks. The key idea of DRESEP is moving gathered information from sensor nodes to cluster head (CH) depending upon perceived changes. Dual-hop communication between CHs and base station is introduced to achieve energy minimization. Further, the results demonstrate that the proposed algorithm significantly outperforms existing algorithms in terms of energy optimization and system lifetime.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
June 2015, Volume 40, Issue 6, pp 1607-1621

Optimal Strategies Modeling in Electricity Market for Electric Vehicles Integration in Presence of Intermittent Resources

- N. Zareen , M. W. Mustafa , Saleh Y. I. AbuJarad , M. Moradi

Abstract:

Electric vehicles (EVs) as an alternative to the current fossil fuel vehicles represent the most promising green approach to electrification of an important portion of the global transportation sector. This uncertain load brings new challenges to market-oriented demand response programs (DRPs) specifically in the presence of renewable energy resources (RER). Being a special type of load, EVs are highly capable of providing a significant amount of flexible load demand through participating in various types of DRPs, while using their battery storage potentials allows a higher penetration level of intermittent RER in the grid. Therefore, there is a strong need to increase EV owner's participation in the market by providing attractive financial benefit-based decision-making tools and simplifying the market process to enhance system reliability and reduce price volatility. In this paper, a novel optimal decision-making methodology is proposed which, unlike previous works, utilizes a grid characteristic's model within a game-theoretical approach, conflicting and capturing economic interests of both players together and evaluates the optimum strategies for a successful market operation in simplest way. This approach can facilitate both EV owners and utilities to derive their robust bidding strategies, in which they can create a simple business case analysis to weigh their benefits of participation in the market. To evaluate the performance, a simulation framework with uncertain load demands and generation has been developed and compared. The results show that the proposed strategy is appropriate for use in real-time automated DRPs.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
August 2015, Volume 40, Issue 8, pp 2423-2436

Resistorless Reconfigurable *n*th-Order Filter Based on DPCDTA for Multi-mode Filtering Applications

- Zhenhua Hu , Chunhua Wang , Zanming Xia , Jun Kuang

Abstract:

This paper presents a new topology for realizing current-mode reconfigurable *n*th-order filter for multi-mode wireless communication equipments, which is based on a new active device, namely digitally programmable current differencing transconductance amplifier (DPCDTA). The proposed filter is resistorless, and it employs *n* DPCDTAs and *n* grounded capacitors with one input and one output terminals. The signal path of the filter does not contain any switches, and wide tuning coefficient of the filter is implemented using programmable current division network with zero standby power consumption in the DPCDTA. Also, the proposed topology exhibits broader programmable features to accommodate wide range of selectivity requirements, which can be used as the most compatible structure for field-programmable analog array and very suitable for multi-mode filtering applications. The programming ability of variable filter orders from first to fourth providing low-pass, high-pass, and band-pass responses, and programming ability of variable cutoff frequencies from 1.14 to 11.75 MHz are given as application examples. The performance of the circuits have been verified and evaluated through post-layout simulations using Cadence IC5141 with *GlobalFoundries' 0.18 μm* CMOS process.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2653-2670

Robust Repetitive Current Control of Two-Level Utility-Connected Converter using LCL Filter

- Mohsin Jamil, Usman Rashid , Rizwan Arshad , M. Nasir Khan , Syed Omer Gilani , Yasar Ayaz

Abstract:

This paper investigates the implementation and performance limits of conventional and odd-harmonic repetitive controllers used for current control of two-level grid-connected inverter. This research is motivated by the relatively poor performance of classical (PI) controller when utility voltage has high harmonic distortion. Repetitive controllers (RCs) have the ability to track or reject periodic signals. However, their effectiveness is limited severely by the scarce bandwidth of the plant. To address this issue, the relationship between plant bandwidth and the converter's LCL filter is also investigated. In addition, the effects of variation in parameters of low-pass filter used in RC loop on the performance of the system are studied. Odd-harmonic repetitive controller (ORC) is used to overcome the excessive memory requirement in RC implementation. The performance of RC and ORC is tested for different total harmonic distortion (THD) values of utility voltage. The results show that RC improves steady state error and THD of the output current. Also, RC is found to be robust under variations in output-side inductance.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2671-2683

Performance of Multiuser Mixed RF/FSO Relay Networks with Generalized Order User Scheduling and Outdated Channel Information

- Anas M. Salhab

Abstract:

The generalized order user scheduling is among the efficient user selection schemes which can be used in conditions where the opportunistic scheduling could fail. The opportunistic scheduler could erroneously select a user other than the best user for data transmission or reception due to imperfect channel estimation or outdated channel information issues. In this paper, we study the performance of multiuser mixed radio frequency (RF)/free-space optical (FSO) relay network with generalized order user scheduling. Due to its importance on the system performance, the outdated channel information problem is also addressed in this paper. The considered system includes K sources or users, one decode-and-forward relay and one destination. The users are connected with the relay node through RF links, and the relay is connected with the destination through an FSO link. In the analysis, the first-hop channels are assumed to follow Rayleigh fading model and the second-hop channel is assumed to follow Gamma–Gamma fading model including the effect of pointing errors. Closed-form expressions are derived for the outage probability, average symbol error probability and ergodic channel capacity. Moreover, in order to get more insights about the system behavior, the system is studied at the high signal-to-noise ratio regime where the diversity order and coding gain are provided and studied. Monte Carlo simulations are given to validate the achieved exact and asymptotic results. Main findings illustrate that under weak atmospheric turbulence conditions, the system performance is dominated by the RF links and a diversity order of $K - N + 1$ is achieved by the system, whereas under sever atmospheric turbulence conditions, the system is dominated by the FSO link and the diversity order is related to the minimum value of the turbulence fading and pointing error parameters.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2641-2651

An Efficient ANFIS-Based PI Controller for Maximum Power Point Tracking of PV Systems

- M. A. Abido , M. Sheraz Khalid , Muhammed Y. Worku

Abstract:

In this paper, an efficient adaptive neuro-fuzzy inference system (ANFIS)-based PI controller for maximum power point tracking (MPPT) of photovoltaic (PV) systems is proposed. The proposed ANFIS-based MPPT controller has the capacity to track the optimum point under the rapidly changing irradiation conditions with less fluctuations in steady state. The training data of the proposed controller are extracted from a precise PV model developed. The performance of the proposed controller is compared with the conventional incremental conductance method. Finally, the proposed ANFIS-based MPPT controller has been implemented experimentally using real-time digital simulator (RTDS) to simulate a PV system in real time, while the proposed ANFIS-based controller is implemented on dSPACE 1104 controller. Simulation and experimental results show that the proposed ANFIS-based MPPT controller has fast and accurate dynamic response with less fluctuations in steady state. In addition, its performance is superior as compared to the conventional methods.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2609-2617

Prediction of the Levels of Contamination of HV Insulators Using Image Linear Algebraic Features and Neural Networks

- Luqman Maraaba, Zakariya Al-Hamouz , Hussain Al-Duwaish

Abstract:

Contaminated high-voltage (HV) insulators in polluted areas may lead to flashovers if they are not cleaned periodically. Flashover often leads to lengthy service outages and thus has a considerable impact on power system reliability. Therefore, an accurate prediction of the contamination level of HV insulators is vital. In this study, a MATLAB-based algorithm for predicting the contamination level is proposed. The algorithm uses the extracted features (in this work, linear algebraic features) from images captured by digital cameras as an input to a neural network. When compared to existing methods reported in the literature, the designed neural network correlates successfully the captured insulator images and the contamination level when tested on unseen insulators.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2571-2583

Analytical- and Simulation-Based Analysis for Optimum Erbium-Doped Fiber Amplifier (EDFA) Performance

- Ibrahim M. M. Mohamed, Mohammad Syuhaimi Ab-Rahman

Abstract:

In this paper, analytical and simulation models were used to analyze the performance of the erbium-doped fiber amplifier in terms of its pump power, erbium-doped fiber length, overlap factor, erbium ions concentration, and input signal power. The analytical-based analysis was performed using MATLAB software, whereas the simulation-based analysis was performed using Optisystem software. Both the analytical- and simulation-based results agreed well. For example, both confirmed the followings: Maximum gain can be reached at a shorter fiber length as the overlap factor and erbium ions concentration increase; the gain is independent of the pump power at values of erbium-doped fiber lengths ≤10m; that almost equal erbium-doped fiber gains can be obtained as the pump power approaches its highest value and that the gain seems to be equal at low values of input signal powers; however, it starts to saturate as the input signal power increases.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2629-2640

Discriminative Training for Phonetic Recognition of the Holy Quran

- Mirza Muhammad Ali Baig , Saad Ahmed Qazi , Muhammad Bilal Kadri

Abstract:

This paper presents the development of Holy Quran recitation recognizer. The decoder of recognizer performs sub-word level recognition at phoneme. The paper demonstrates high recognition accuracies achieved by applying incremental refinements to the HMM models of the phonemes during the training stage. The Maximum- likelihood (ML) criterion is first applied for HMMs parameter estimation, which produces average recognition accuracies of up to 83 %. This is followed by discriminative technique of minimum phone error (MPE), which is applied to minimize recognition error at phoneme level. Investigation shows that MPE based acoustic models improve generalization. The results show 3–4 % improvement in recognition accuracies, which are promising when compared with the case of ML approach applied alone.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2619-2628

Parameter Identification of PEM Fuel Cell Using Quantum-Based Optimization Method

- A. K. Al-Othman , Nabil A. Ahmed , F. S. Al-Fares , M. E. AlSharidah

Abstract:

Parameter identification of proton exchange membrane (PEM) fuel cells using quantum-based optimization method (QBOM) is presented in this paper. The QBOM is an algorithm that is adapted from certain elements of quantum computing aimed for use in a wider class of search and optimization problems. QBOM is composed of qubits and quantum gates. The quantum gate evolves the qubits until the desired objective is achieved, while qubits maintain the information in a superposition for all states. This novel optimization technique presents innovative insight in finding the best answer. Unlike other evolutionary search mechanism philosophies, the QBOM utilizes quantum phenomena to allocate the optimum, while the evolutionary algorithms seek to find the optimal solution using the available information including the best found to assemble the search mechanism with certain rules to avoid trapping in local minima. The proposed method is applied to 1.2 kW Ballard Nexa fuel cell to identify the exact parameters and has been successfully tested experimentally. Results based on parameter identification, simulation and experimental measurements are compared for validation purposes. The outcomes are very encouraging and prove that QBOM is very applicable in parameter optimization of PEM fuel cell.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2015, Volume 40, Issue 9, pp 2585-2608

Analysis of Electromagnetic Fields Generated by Inclined Lightning Channel

- Said I. Abouzeid , Adel Zein El Dein

Abstract:

Evaluation of electromagnetic fields, which is caused by the lightning channel, is an appealing topic in order to consider the indirect effects of lightning on the power lines. In most computations of lightning electromagnetic fields, the return stroke channel is assumed to be a straight and a vertical channel. However, in reality, the lightning channel is most often inclined and has some tortuosity on scales. This paper provides general expressions for the electric field and the magnetic flux density, at any point, that are radiated from an inclined lightning channel. These general expressions are based on the Maxwell's equations. The proposed equations can estimate the components of the electric field and the magnetic flux density directly at any observation point and for any kind of lightning channel (vertical or inclined). Also, by using the suggested general expressions, the electromagnetic fields can be computed in close, medium and far ranges. The proposed expressions support the notion of the vertical lightning channel by assuming the channel angle with respect to Z-axis equals zero. In this paper, the analysis of the suggested expressions for the electric field and the magnetic flux density that radiated from an inclined lightning channel as well as their verifications by comparing their results with the results of the others is achieved. Also, these suggested expressions are used to investigate the effect of channel geometry, number of the segments to which the channel is sub-divided, position of the observation point with respect to each segment of the channel, and each segment orientations (defined with the azimuth angle ϕ) and inclination angle θ on the electromagnetic field distributions.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
November 2015, Volume 40, Issue 11, pp 3247-3261

Solving Unit Commitment Problem Using Multi-agent Evolutionary Programming Incorporating Priority List

- M. N. C. Othman , T. K. A. Rahman , H. Mokhlis , M. M. Aman

Abstract:

This paper presents an approach to solve the unit commitment problem using a newly developed Multi-agent Evolutionary Programming incorporating Priority List optimisation technique (MAEP-PL). The objective of this study is to search for generation scheduling such that the total operating cost can be minimised when subjected to a variety of constraints, while at the same time reducing its computational time. The proposed technique assimilates the concepts of Priority Listing (PL), Multi-agent System (MAS) and Evolutionary Programming (EP) as its basis. In the proposed technique, deterministic PL technique is applied to produce a population of initial solutions. The search process is refined using heuristic EP-based algorithm with multi-agent approach to produce the final solution. The developed technique is tested on ten generating units test system for a 24-h scheduling period, and the results are compared with the standard Evolutionary Programming (EP), Evolutionary Programming with Priority Listing (EP-PL) and Multi-agent Evolutionary Programming (MAEP) optimisation techniques. From the obtained results and the comparative studies, it was found that the proposed MAEP-PL optimisation technique is able to solve the unit commitment problem where the total daily generation cost is effectively minimised and the computation time is reduced as compared to other techniques.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
December 2015, Volume 40, Issue 12, pp 3607-3626

Design and Performance Analysis of a PWM dc–dc Buck Converter Using PI–Lead Compensator

- Man Mohan Garg , Yogesh Vijay Hote , Mukesh Kumar Pathak

Abstract:

This paper presents a proportional–integral–lead (PI–lead) compensator design based on frequency domain specifications to regulate the output voltage of pulse width modulated dc–dc buck converter. In this design, the parameters of PI–lead compensator are tuned in two parts such that the PI section improves the steady-state response, whereas lead section improves the transient response of the uncompensated system. Further, the detailed performance analysis is carried out in order to obtain optimal value of phase margin and gain crossover frequency for dc–dc buck converter. Finally, this control strategy is verified through MATLAB/Simulink simulation and is implemented on an experimental setup using dSPACE DS1104 digital signal processor. The experimental results validate the simulation results and indicate the robustness of the compensator under wide variations in input voltage, load current and desired output voltage.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
December 2015, Volume 40, Issue 12, pp 3595-3605

A New Non-isolated ZCS Bidirectional Buck–Boost DC–DC Converter for Energy Storage Applications in Electric Vehicles

- Veera Venkata Subrahmanya Kumar Bhajana , Pavel Drabek

Abstract:

This paper proposes a new ZCS non-isolated bidirectional buck–boost DC–DC converter for energy storage applications. The conventional bidirectional converter derived with auxiliary edge resonant cell to obtain ZCS turn-on/turn-off condition of the main switches. The proposed converter is operated in boost and buck modes with soft-switching operations in order to have minimized current stresses and reduced switching losses since the resonating current for the zero-current switching does not flow through the main switches. The proposed converter improves the overall efficiency over hard-switching converter for high-power energy storage applications. This paper mainly describes the operation principles of the topology, simulation evaluation, and its validation by the experimental results on 50 V–120 V–300 W system, which proved the soft-switching capability of this converter and its performance.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
February 2016, Volume 41, Issue 2, pp 513–525

Spectrum-Sharing AF Relay Networks with Switch-and-Examine Relaying and Multiple Primary Users Using Orthogonal Spectrums

- Anas M. Salhab, Salam A. Zummo

Abstract

In this paper, we propose and evaluate the behavior of a new cognitive amplify-and-forward relaying scenario where the multiple primary users utilize orthogonal spectrum bands. Using orthogonal bands aims to reduce the interference between users as in the downlink transmission in cellular networks where a base station transmits the data of different users using orthogonal frequency bands. In the proposed scenario, the spectrum of the primary user whose channel enhances the secondary system performance is shared with the secondary users. In this paper, the low-complexity switch-and-examine diversity combining relaying scheme is used to select among the secondary relays. In this scheme, the relay whose end-to-end signal-to-noise ratio (SNR) satisfies a predetermined switching threshold is selected instead of the best relay to forward the source message to destination. Approximate expressions are derived for the outage probability and average symbol error probability of the studied system assuming Rayleigh fading channels. Also, the ergodic channel capacity is numerically calculated in this paper. Furthermore, to simplify the achieved expressions and to get more insights about the system behavior, the system is studied at the high SNR values where approximate expression is derived for the outage probability in addition to the derivation of the diversity order and coding gain of the system. The achieved results are validated by Monte Carlo simulations. Main findings illustrate that the diversity order of the studied system is the same as its non-cognitive counterpart and it is independent of the primary network. In contrast to the existing systems where the same spectrum band is utilized by different primary users, increasing the number of primary users in the proposed scenario enhances the overall behavior via improving the coding gain.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
February 2016, Volume 41, Issue 2, pp 527–543

State Space Least Mean Fourth Algorithm for Dynamic State Estimation in Power Systems

- Arif Ahmed, Muhammad Moinuddin, Ubaid M. Al-Saggaf

Abstract

Power system dynamic state estimation (DSE) has always been a critical problem in studying power systems. One of the essential parts of power systems are synchronous machines. In this work, we dealt with the problem of DSE of a synchronous machine by introducing a novel state space-based least mean fourth (SSLMF) algorithm. The rationale behind the proposed algorithm is the fact that a power system may encounter non-Gaussian disturbances/state errors and the least mean fourth algorithm is proven to be better in such environments. Moreover, we have also introduced a normalized version of the proposed algorithm, namely state space normalized least mean fourth (SSNLMF) algorithm to deal with the stability issue under Gaussian disturbances. Another motivation for developing the SSLMF algorithm is its simplicity as compared to other model-based nonlinear filtering algorithms such as Kalman filter, extended Kalman filter (EKF). Moreover, we also investigate the performance of the recently introduced state space least mean square (SSLMS). Performance of the SSLMF and the SSLMS is compared with existing EKF in both Gaussian and non-Gaussian noise environments. Extensive simulation results are presented which show superiority of the proposed algorithms, and hence, it verifies our rationale behind the work.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
February 2016, Volume 41, Issue 2, pp 545–553

Stochastic Dynamic Economic Dispatch for Grids with Significant Wind Using Mixed Gaussian Distribution

- Ali T. Al-Awami, M. Abdul Hafeez Ansari, Brian J. Bennett

Abstract

Generation scheduling is becoming a challenge in power grids with high penetration of renewable energy sources due to their stochastic nature. In this paper, an efficient stochastic multi-period dynamic economic dispatch (DED) model is presented. It allocates optimally generation levels among the online thermal generators in a way that maximizes the utilization of wind resources. In order to accommodate wind uncertainty, the conditional probability distribution function of the wind power output given the forecast level is used. Mixed Gaussian (MG) distribution is utilized for wind uncertainty characterization as it greatly enhances computational speed and accuracy. The statistical analysis shows the advantages of MG function over other distributions presented in the literature. Simulation results of a system with thermal and wind power plants show the merits of the proposed MG-based stochastic DED methodology.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
February 2016, Volume 41, Issue 2, pp 555–567

Mobile Traffic Offloading in Heterogeneous Networks-Based Small Cell Technology

- Saied M. Abd El-atty, Z. M. Gharsseldien, Saied M. Abd El-atty

Abstract

In this paper, we propose an efficient heterogeneous network (HetNet) architecture with coexisting small cell technology to provide capacity and coverage expanding in 3G and 4G mobile networks. A hierarchical HetNet layout comprises of three layers macro-, metro- and femtocell. The metrocell is employed as an intermediate layer in the integrated femtocellular/macrocellular network, which operates in a complementary fashion, in order to manage the handover traffic between the edge layers. Consequently, the femtocell serves indoor traffic activity of femto users, while metrocell serves the outdoor traffic activities as well as the overflow traffic from femtocells. The overall HetNet is completed with the macrocell overlay layer, which serves only the macro users and the overflowed traffic from the underlay layer. Then, we develop a realistic teletraffic framework in order to evaluate the performance of the proposed HetNet. We show both analytically and by simulation that the proposed HetNet architecture with coexisting small cells is able to offload traffic from traditional macrocellular network in terms of reducing the blocking probability.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3297–3307

U-Shape Slot Antenna Design with High-Strength $Ni_{54}Ti_{46}$ Alloy

- Adnan Kaya, Irfan Kaya, Haluk E. Karaca

Abstract

In this paper, a compact, printed, capsule- U-shape ultra-high-strength $Ni_{54}Ti_{46}$ antenna that can be used in biomedical and communication applications is presented. An accurate electromagnetic model of the shape memory alloy antenna is developed using CST Studio for numerical analysis. The 10 dB return loss bandwidth of the proposed $Ni_{54}Ti_{46}$ antenna is 8 % GHz, which covers the recently proposed 802.11 and 802.15 applications. Radiation performance has been evaluated using FIT simulation to show that the proposed antenna can be used for ISM band telemetry applications. $Ni_{54}Ti_{46}$ U-shape antenna operating at 2.4 GHz having 50 beamwidth and 6.96 dBi gain has been utilized as a reference antenna. The impedance bandwidth of the antenna has been enhanced from 4.2 to 8 % by using aged $Ni_{54}Ti_{46}$ alloy. However, the conductivity increased after the aging process and antenna's return loss and frequency levels are shifted. In addition, it has been shown that $Ni_{54}Ti_{46}$ antenna significantly develops the radiation pattern. The computed and measured results showed good agreement for copper, aluminum and $Ni_{54}Ti_{46}$ antennas.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3309–3320

Novel Hybrid Load-Frequency Controller Applying Artificial Intelligence Techniques Integrated with Superconducting Magnetic Energy Storage Devices for an Interconnected Electric Power Grid

- Thi-Mai-Phuong Dao, Yaonan Wang, Ngoc-Khoat Nguyen

Abstract

The focus of this work is to design a novel hybrid load-frequency control (LFC) strategy for a multi-area large-scale electric power interconnection. The proposed methodology is based on two consecutive control phases, including an artificial neural network model and a PD-like fuzzy logic inference system. The new two-stage architecture enables this control strategy to utilize the advantage of each phase, and thus it is able to enhance the robustness of the LFC controller to quickly restore the steady state of the network after load variations. In addition, superconducting magnetic energy storage (SMES) devices, which can powerfully compensate for the loss of energy in an electric power grid, are investigated to support the LFC scheme. The integration of the novel hybrid LFC controller and the SMES devices in a large-scale network is completely capable of being a promising control solution for maintaining the system frequency against the load variations. The feasibility and superiority of the proposed control strategy over the conventional PI regulators as well as a number of previous studies will be demonstrated through numerical simulation processes with various load conditions implemented in a six-control-area electric power interconnection.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3321–3334

Modifying MVDR Beamformer for Reducing Direction-of-Arrival Estimation Mismatch

- Omar Khaldoon Abdulrahman, Md. Mijanur Rahman

Abstract

The minimum variance distortionless response (MVDR) beamforming algorithm is used in smart antenna design for wireless communication. The operation of MVDR is based on finding the optimum weight to direct the main lobe beam to the desired user location with a unity gain. MVDR is very sensitive to signature vector mismatch. This mismatch occurs due to waveform deformation, local scattering, imperfect array element calibration and element shape distortion, which leads to errors in finding the direction of arrival (DOA) of the signal. In this paper, a new technique to modify the MVDR is presented, modelled and evaluated. The proposed algorithm is named modified MVDR (MMVDR) and is dependent on reconstructing the signature vector (steering vector) and the covariance matrix to introduce accurate beamformer weight by re-localization the reference element to be in the middle of ULA, rather than at one end side. The new reference position partitions the array's elements into two groups around this reference, which leads to treat received signals with identical phase along the array's elements, as well as increasing the degree of freedom to deals with different types of uniform arrays. The evaluation results show that MMVDR outperforms MVDR with respect to beamformer accuracy, system cost, processing time and signal classification to overcome the errors in DOA estimation which occur due to fabrication and calibration errors.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3335–3343

Optimized Bends and Corporate 1×4 1×4 and 1×8 1×8 SIW Power Dividers Junctions Analysis for V-Band Applications Using a Rigorous Finite Element Method

- Fellah Benzerga, Mehadji Abri

Abstract

In this paper, two classes of V-band substrate integrated waveguide (SIW) bends operating in V-band frequency in the range [58–63 GHz] for the 90 ◦ 90◦ SIW bend with inductive via and in the range [57–68 GHz] for the circular SIW bend and corporate 1×4 1×4 and 1×8 1×8 SIW power dividers that provide equal power split with high isolation in all output ports operating in V-band [45–80 GHz] are presented and studied. The advantages of the SIW technique are its low profile, low cost, mass production, ease of fabrication and full integration with planar circuits. All the SIW bend topologies are optimized and designed to operate in the V-band frequency range. The bends and dividers are analyzed using the two-dimensional finite element method (2D-FEM). The analysis was performed in H-plane using a powerful full-wave method based on the two-dimensional finite element method (2D-FEM) programmed under MATLAB environment. The return losses, transmission coefficients and the field's distribution are exposed in this paper. To validate our results numerically, a comparison is made and the obtained results are compared with those given by the CST Microwave Studio. It is observed that the simulation computation time is reduced with good accuracy since the discretization was done only in two dimensions.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3345–3354

Self-adaptive Differential Evolution-Based Multiple Model Variable Rate Particle Filter for Trajectory Tracking

- Ghasem Saeidi, M. R. Moniri, Ali Shahzadi

Abstract

In fixed rate, state space models are conventionally used to track the maneuvering objects. In contrast to fixed rate models, recently introduced variable rate particle filter (VRPF) is capable of tracking the target with a small number of states by imposing a Gamma distribution on the state arrival times, while the object trajectory is approached by a single dynamic motion model. It cannot estimate the position of targets in very high maneuvering regions. Thus, multiple model VRPF (MM-VRPF) method is utilized to overcome this shortage using various dynamic models. A weak point of particle filter is a phenomenon called degeneracy which even exists in MM-VRPF structure. In this study, differential evolution method is exploited to improve the mentioned method, and a novel structure called MM-VRPF with self-adaptive differential evolution is introduced. The simulation results, particularly those related to bearing only tracking achieved from the maneuvering target, revealed that the proposed structure has high performance, while it still takes advantage of variable rate structure.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3355–3367

Performance Evaluation of FPGA-Controlled DSTATCOM for Load Compensation

- Venkatraman Kandadai, Moorthi Sridharan, Selvan Manickavasagam Parvathy

Abstract

This paper presents an implementation and performance analysis of a three-phase distribution static compensator (DSTATCOM) for various compensations in a system with static and dynamic loads. Under static loading condition, DSTATCOM is used for reactive power compensation, harmonic elimination and load balancing. During dynamic loading condition, induction machine is considered as a dynamic load by operating it as motor/generator and the dynamic reactive power support capability of DSTATCOM is explored. Synchronous reference frame theory is utilized for reference signal generation and hysteresis pulse width modulation switching is employed for firing pulse generation, which are implemented in field-programmable gate array (FPGA). All the tasks in FPGA are realized as independent modules to build the system with the capability to reconfigure the hardware for any other application with similar requirements. The proposed FPGA implementation utilizes reduced amount of reconfigurable resources and works without a dedicated personal computer. The experimental results prove that the implemented control technique makes the supply current sinusoidal and the supply power factor close to unity.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3369–3379

Artificial Neural Network Approach for Predicting the Water Turbidity Level Using Optical Tomography

- Mohd Taufiq Mohd Khairi, Sallehuddin Ibrahim

Abstract

Water pollution can occur with a variety of reasons such as the change in water colour, the presence of harmful bacteria and toxic waste spills. This paper presents an application of an optical tomography system based on artificial neural network (ANN) to predict the turbidity level of water sample. The system made use of the independent component analysis algorithm to calculate the *K* value, which indicates the attenuation value of the water turbidity level. The *K* value then is utilized by ANN to estimate the turbidity level. The optical tomography system can be used to evaluate the water turbidity level in the pipeline without disturbing the flow process. Evaluation of the mean square error (MSE), sum square error (SSE) and regression analysis (R) also enabled us to determine the network performance which demonstrated that the neural network is effective in inspecting the water turbidity level. The best neurone structure is revealed when two hidden layers with 20 and 10 neurones in the first and the second layer, respectively, are used. The training result shows 9.7147×10^{-7} 9.7147×10^{-7} for MSE, 0.1432 for SSE and 0.99911 for regression. For the testing part, the result for the neurone structure is 8.1473×10^{-5} 8.1473×10^{-5} for MSE, 0.7509 for SSE and 0.98525 for regression. The results revealed that the performance of ANN demonstrated a good prediction capability when the turbidity level changed. Thus, an optical tomography system with ANN proved to be an efficient tool to classify the water quality level and is beneficial to the water industry.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3381–3397

Optimal Application of Fault Current Limiters for Assuring Overcurrent Relays Coordination with Distributed Generations

- A. Elmitwally, E. Gouda, S. Eladawy

Abstract

This paper addresses the problem of overcurrent relays (OCRs) coordination in presence of DGs. OCRs are optimally set to work in a coordinated manner to isolate faults with minimal impacts on customers. Penetration of DGs into the power system changes the fault current levels seen by the OCRs. This can deteriorate the coordinated operation of OCRs. Operation time difference between backup and main relays can be below the standard limit or even the backup OCR can incorrectly work before the main OCR. Though resetting of OCRs is tedious especially in large systems, it cannot alone restore the original coordinated operation in the presence of DGs. The paper investigates the optimal utilization of fault current limiters (FCLs) to maintain the directional OCR-coordinated operation without any need to OCRs resetting irrespective of DGs status. It is required to maintain the OCRs coordination at minimum cost of prospective FCLs. Hence, the FCL location and sizing problem are formulated as a constrained multi-objective optimization problem. Multi-objective particle swarm optimization is adopted for solving the optimization problem to determine the optimal locations and sizes of FCLs. The proposed algorithm is applied to meshed and radial power systems at different DGs arrangements using different types of FCLs. Moreover, the OCR coordination problem is studied when the system includes both directional and non-directional OCRs. Comparative analysis of results is provided.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3399–3405

An Energy-Efficient Cooperative Spectrum Sensing Strategy with Robustness Against Noise Uncertainty for Cognitive Radio Networks

- J. Christopher Clement, B. Bharath Reddy,D. S. Emmanuel

Abstract

In the recent past, the energy-efficient feature of cognitive radio networks has drawn the attention of many researchers. This is due to rapid growing demand of green environment standards and escalation in the growth of energy consumption costs. The work reported in the literature was developed for the sensing environment where the noise variance remains constant, which is not true in real life. This paper proposes a robust energy-efficient cooperative spectrum sensing strategy, which is immune to noise uncertainty. Coarse and fine sensing schemes are employed in the proposed method to achieve energy-efficient feature. Simulation upshots show that energy consumption is reduced significantly with revamped detection performance against noise uncertainty in the proposed technique.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3407–3414

Application of a Galaxy-Based Search Algorithm to MIMO System Capacity Optimization

- Abdelmadjid Recioui., Abdelmadjid Recioui

Abstract

The objective of this paper is to use the recently proposed galaxy-based search optimization algorithm to enhance the capacity of a multiple input multiple output (MIMO) system with rectangular arrays at both communication ends (transmitter and receiver). This new optimization tool has been recently introduced and is a metaheuristic technique inspired by the dynamics of galactic arm spirals. It is characterized by its robustness, immunity to local optima trapping, relative fast convergence and ease of implementation. The idea is to extend the results obtained for the one-dimensional array geometry to the two-dimensional case. The purpose is to find out which array geometrical dimensions produce the highest capacity value. Compared to the linear array case, promising capacity values are found using the two-dimensional arrays which suggests their deployment in future MIMO communication systems.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3415–3423

Effect of Design and Operating Parameters on the Performance of Planar and Ducted Cathode Structures of an Air-Breathing PEM Fuel Cell

- Attuluri R. Vijay Babu, Pantalingal Manoj Kumar, Gorantla Srinivasa Rao

Abstract

In this study, the effect of operating parameters such as cell orientation and ambient temperature with three different types of planar and ducted cathode designs of air-breathing fuel cells (ABFCs) is investigated. Membrane electrode assemblies with varied (10, 30, 40 and 50 %) hydrophobisation on cathode side and 10 % hydrophobisation on anode side are fabricated. The paper throws light on the performance of fuel cell with varied hydrophobisation on cathode side of the fuel cell. It is found that vertical channel orientation is the best orientation for an ABFC to operate due to its higher performance in both ducted and planar cathode designs. Also, based on the results, it can be concluded that the ambient temperature has a significant effect on the performance of an ABFC.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3425–3439

Cluster-Based Cooperative Subcarrier Sensing Using Antenna Diversity-Based Weighted Data Fusion

- Bushra Mughal, Sajjad Hussain, Abdul Ghafoor

Abstract

Cooperative spectrum sensing (CSS) is used in cognitive radio (CR) networks to improve the spectrum sensing performance in shadow fading environments. Moreover, clustering in CR networks is used to reduce reporting time and bandwidth overhead during CSS. Thus, cluster-based cooperative spectrum sensing (CBCSS) has manifested satisfactory spectrum sensing results in harsh environments under processing constraints. On the other hand, the antenna diversity of multiple input multiple output CR systems can be exploited to further improve the spectrum sensing performance. This paper presents the CBCSS performance in a CR network which is comprised of single- as well as multiple-antenna CR systems. We give theoretical analysis of CBCSS for orthogonal frequency division multiplexing signal sensing and propose a novel fusion scheme at the fusion center which takes into account the receiver antenna diversity of the CRs present in the network. We introduce the concept of weighted data fusion in which the sensing results of different CRs are weighted proportional to the number of receiving antennas they are equipped with. Thus, the receiver diversity is used to the advantage of improving spectrum sensing performance in a CR cluster. Simulation results show that the proposed scheme outperforms the conventional CBCSS scheme.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3441–3449

Design and Analysis of Self-Healing Dual-Ring Spectral Amplitude Coding Optical Code Division Multiple Access System

- Waqas Ahmed Imtiaz, Yousaf Khan, Khalid Mahmood

Abstract

Conventional tree-based optical code division multiple access (OCDMA) systems do not provide any protection between optical line terminal and optical network units. This makes the entire OCDMA system significantly vulnerable to failures. This paper proposes a novel dual-ring spectral amplitude coding (SAC) OCDMA system, which consists of a single ring at the feeder level and two semi-rings at the distribution level. Analysis shows that the proposed system immediately detects and restores the flow of affected traffic and ensures survivability of the entire network. Moreover, comparison of the proposed system with exiting protection schemes shows that the proposed dual-ring SAC-OCDMA system provides desirable availability, 99.9995%, with minimum expenditure through simple architecture and simultaneous protection against failures at both feeder and distribution rings.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3451–3461

A Novel Neural Network Approach to Transformer Fault Diagnosis Based on Momentum-Embedded BP Neural Network Optimized by Genetic Algorithm and Fuzzy c-Means

- Kefei Zhang, Fang Yuan, Jiang Guo

Abstract

Transformer is one of the critical equipments for electric power transmission and distribution, and its safety situation plays an important role on stability and security level of power systems. Therefore, the diagnosis of its abnormal situation has always drawn enormous attention from both domestic and international scholars. Dissolved gas analysis (DGA) is a widely used method in transformer fault diagnosis field. However, the conventional DGA is not well suitable for transformer fault diagnosis because transformer's structure is complex and operating environment is changeable. On the other hand, the back propagation (BP) neural network, frequently employed in related field, also has some inherent disadvantages, such as local optimization, over-fitting and difficulties in convergence. So simply integrating conventional DGA to BP is not a good approach for fault diagnosis. Moreover, disturbance or noises within the training data, which is unavoidable due to systematic errors, may greatly influence the accuracy of diagnosis model with the growing size of the data. Thus, in this study, we integrate a combination ratio of taking advantages of IEC and Doernenburg, instead of usual DGA, into genetic algorithm (GA) and fuzzy c-means clustering algorithm (FCM) optimized BP, successfully building a novel model which has not been reported previously. Our results show this model has a better diagnosis accuracy rate and generalization ability than other models, and FCM and GA can significantly overcome the disadvantages of training data and BP, offering the potential of implementation for real-time diagnosis systems.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3463–3471

A Non-Invasive Method for Condition Monitoring of Induction Motors Operating Under Arbitrary Loading Conditions

- Muhammad Irfan, Nordin Saad, Rosdiazli Ibrahim

Abstract

The literature review presents the various kinds of existing condition monitoring methods and highlights the need for an economical, intelligent fault diagnosis system for the motors that are being used in variable load applications. The motor current signature analysis (MCSA) has been used widely in previous research work for fault detection of the motor at full-load conditions. However, MCSA cannot detect faults under low-load conditions of the motor. This paper proposes the instantaneous power analysis (IPA) method for the bearing fault detection at various loading conditions of the motor. The experimental results indicate that IPA has more capability to detect faults under low-load conditions as compared to MCSA. Also, it has been shown that IPA carries an additional characteristic vibration frequency component which provides an extra piece of information that can be utilized in a reliable intelligent condition monitoring system. The proposed method has been validated through experiments at five different loading conditions of the motor.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3473–3489

Simple Approach to Design PID Controller via Internal Model Control

- Sahaj Saxena, Yogesh V. Hote

Abstract

The internal model control (IMC)-based PID controller is widely used in industrial control problems. This scheme provides a good compromise among set-point tracking, disturbance attenuation, and robustness. Therefore, in this paper, we propose a simple technique to design IMC-PID controller. To illustrate the utility of the proposed technique, different types of linear and nonlinear second-order systems and approximated second-order models of higher-order systems are simulated. The proposed approach depicts quick response to set-point change, good disturbance attenuation, and optimal performances in most of the class of problems when compared to the conventional IMC-PID and other existing popular techniques. The beauty of this paper is that there is no need of highly complex mathematical approaches, and using only simple conventional IMC approach, the improved servo and regulatory results can be achieved.

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Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3491–3500

Design Optimization of Cast-Resin Transformer Using Nature-Inspired Algorithms

- Davood Azizian, Mehdi Bigdeli, Jawad Faiz

Abstract

In the recent years, cast-resin dry-type transformers (CRT) are considerably used in various areas of the electrical power industry. The major properties of these transformers include inflammability and moisture protection. This is the reason that they are an appropriate alternative for oil-immersed transformers in residential, hospitals, ships and other areas. Large number and discontinuity of design parameters cause the design optimization and automation in the CRT to be complicated. In this paper, structure of the CRT and its design parameters are proposed. Three methods based on genetic algorithm, particle swarm optimization (PSO) and artificial bee colony are introduced for optimization and design automation of the CRT. These methods are applied to design a typical transformer, and the results are compared and discussed. It is shown that PSO is the best optimization technique which converges to optimal solution quickly.

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Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3501–3510

Mathematical Modeling of Critical Parameters on the Polluted Ceramic Insulators Under AC Voltage: Based on Experimental Tests

- Mousalreza Faramarzi Palangar, Mohammad Mirzaie

Abstract

In this paper, a mathematical model of critical parameters on the polluted ceramic insulators based on experimental analysis has been presented. In these cases, the effect of pollution and humidity on the leakage current and applied voltage of the insulators has been investigated. Also, the effect of the insulator shed on the critical parameters has been considered as the factor *M*. The profile factor *M* is the ratio of top level leakage distance to bottom leakage distance of insulator. Indeed, the value of the factor *M* has been defined as a criterion in experimental tests to determine the insulators' electric strength. As well, to determine the constants of electric arc, the theoretical and experimental results have been compared, thus values of these constants have been determined. So, by presented mathematical model the critical parameters will be predicted. The closeness of results between proposed mathematical model and experiment confirms the veracity of the presented model.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3511–3519

Joint Frequency and Time Estimation Algorithms

- Nizar Tayem, Syed Ahmed Raza, Muhammad Omer

Abstract

In this paper, we present six subspace decomposition based methods for joint time of arrival (TOA) and frequency of arrival (FOA) estimation of multiple incident sources. These are LU-TLS, QR-TLS, direct TSQR-TLS, direct TSLU-TLS, parallel TSQR-TLS, and parallel TSLU-TLS. The direct and parallel TSQR/TSLU-TLS are recently developed methods in subspace decomposition and are employed in this work for time and frequency estimation. The proposed methods employ a pair of spatially separated sensors to receive multiple incident source signals. A data matrix is constructed in the form of a Hankel matrix from multiple snapshots of the received signal. The information of both TOA and FOA of multiple incident sources is extracted from the data matrix by applying LU/QR techniques (in the first set of the methods) and a tall skinny TSLU/TSQR factorization in the second set. The estimates of the TOA and FOA are obtained from the signal subspace by applying the total least squares (TLS) method. Simulation results are presented to assess the performance of the proposed methods. The effect of parametric variations on the performance has also been analyzed for all the proposed methods. Further, the computational times and complexities of the proposed methods are also computed and compared with each other.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3521–3530

An Intelligent System for Vehicle Access Control using RFID and ALPR Technologies

- M. Mohandes, M. Deriche, H. Ahmadi, M. Kousa, A. Balghonaim

Abstract

This paper introduces a hybrid system for vehicle access control using RFID and automatic license plate recognition (ALPR) technologies. RFID technology is proven to provide an effective solution to different tracking and localization problems. However, the technology has its shortcomings in tracking objects/users without a tag. As such, we propose to complement this technology with ALPR to control the access of different types of vehicles to the area of Makkah (Saudi Arabia) during Pilgrimage seasons. This limited area can easily get congested with the huge number of vehicles attempting access. Before the start of the season, vehicles authorized to access the region are assigned passive RFID tags specifying their allowed schedule of entry. Violating vehicles that do not have RFID tags are detected and identified using ALPR. The developed system was tested over two pilgrimage seasons. The experiments showed that the developed RFID system was able to identify all passing vehicles with speeds up to 100 km/h, while the ALPR system achieved 94 % recognition accuracy of vehicles not equipped with RFID tags.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3531–3542

Output Feedback Control of a Class of Under-Actuated Nonlinear Systems Using Extended High Gain Observer

- Nasir Khalid, Attaullah Y. Memon

Abstract

The problem of output feedback stabilization of a class of under-actuated benchmark nonlinear systems is discussed. The proposed method utilizes an extended high gain observer (EHGO)-based sliding mode control (SMC) technique to control a class of nonlinear systems which may have unstable zero dynamics. Starting with Lagrangian model of the system and using a suitable coordinate transformation, a generalized normal form representation is derived which decouples the system into an internal and external dynamics. The internal dynamics is utilized to derive an auxiliary system and the full-order EHGO thus obtained is used for estimation of derivative(s) of the system output that are further used in design of an output feedback control law. It is shown that the proposed output feedback controller stabilizes the system and convergence of estimated states is demonstrated with suitable selection of observer parameters. The proposed control scheme is applied to a benchmark nonlinear system, namely inertia wheel pendulum (IWP), in order to demonstrate the efficacy of the technique by simulation.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3543–3558

Input–Output Linearization-Based Controller Design for Stand-Alone Solid Oxide Fuel Cell Power Plant

- Ashik Ahmed, Md. Shahid Ullah

Abstract

Application of input–output linearization control for improving the dynamic response of a stand-alone solid oxide fuel cell (SOFC) system is presented in this work. The proposed controllers are incorporated in the study system to eliminate the sluggishness in the hydrogen and oxygen partial pressure responses due to variations in the SOFC reference current. Temperature dynamics of SOFC is taken into consideration to replicate the impact of temperature variation on the system dynamics. Eigenvalue study of the linearized zero dynamics is conducted to determine the stability of the unobservable part of the system, and the remaining dynamics is considered for designing the input–output linearization-based controllers. Pole placement technique is adopted to obtain the controller gains which give the desired dynamic response. The performance of the proposed technique is compared with that of the optimized proportional–integral (PI) controller. The proposed controller efficiency is also tested under varying operating conditions and measurement noise. Simulation results show the efficacy and supremacy of the proposed method in improving the dynamic response of the study system.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3559–3569

Attitude Observers for Accelerated Vehicles Without Accelerometer Measurements

- Saliha Bencheikh, Salim Ibrir, Salah Boukraa

Abstract

In this paper, we present two nonlinear attitude observers for accelerated vehicles moving in 3-D space using a global positioning system, a gyroscope and a magnetometer. These observers are developed based on the idea that for highly dynamic motions, the acceleration or the error affecting acceleration can be strongly related to dynamic changes in velocity errors. The observer error signals are converged to zero in very short time and for any almost initial conditions. Conditions are given to guarantee the asymptotic stability of the system. Simulation results have proven the best performance of the proposed observers compared to results obtained by other observers recently developed in the literature.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3571–3586

A Modified Disturbance Rejection Mechanism in Sliding Mode State Observer for Sensorless Induction Motor Drive

- S. Mohan Krishna, J. L. Febin Daya

Abstract

This paper presents a modified sliding mode state observer for sensorless vector-controlled induction motor drive. The objective is to improve the dynamic performance of the sensorless drive subjected to parameter uncertainty, fault and disturbances. The sensorless drive along with the proposed observer is modeled and built in Simulink, and the dynamic behavior is obtained for different test cases such as flux-weakening region, variations in commanded speed and torque, low-speed operation and under faulty operation mode subjected to an electrical fault in the inverter. The conventional disturbance rejection mechanism is modified by constraining the estimated disturbance along with the stator current error in the sliding surface, thereby increasing the ability of the observer to reject the effect of the external load on the tracking performance. Extensive simulation results prove that the modified observer has a wide speed bandwidth compared to the conventional observer along with superior tracking, disturbance rejection characteristics and torque holding capability.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3571–3586

A Modified Disturbance Rejection Mechanism in Sliding Mode State Observer for Sensorless Induction Motor Drive

- S. Mohan Krishna, J. L. Febin Daya

Abstract

This paper presents a modified sliding mode state observer for sensorless vector-controlled induction motor drive. The objective is to improve the dynamic performance of the sensorless drive subjected to parameter uncertainty, fault and disturbances. The sensorless drive along with the proposed observer is modeled and built in Simulink, and the dynamic behavior is obtained for different test cases such as flux-weakening region, variations in commanded speed and torque, low-speed operation and under faulty operation mode subjected to an electrical fault in the inverter. The conventional disturbance rejection mechanism is modified by constraining the estimated disturbance along with the stator current error in the sliding surface, thereby increasing the ability of the observer to reject the effect of the external load on the tracking performance. Extensive simulation results prove that the modified observer has a wide speed bandwidth compared to the conventional observer along with superior tracking, disturbance rejection characteristics and torque holding capability.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3587–3604

Bat Algorithm: Application to Adaptive Infinite Impulse Response System Identification

- Manjeet Kumar, Apoorva Aggarwal

Abstract

The problem of system identification concerns with the design of adaptive infinite impulse response (IIR) system by determining the optimal system parameters of the unknown system on the minimization of error fitness function. The conventional system identification techniques have stability issues and problem of degradation in performance when modeled using a reduced-order system. Hence, a meta-heuristic optimization method is applied to overcome such drawbacks. In this paper, a new meta-heuristic optimization algorithm, called bat algorithm (BA), is utilized for the design of an adaptive IIR system in order to approximate the unknown system. Bat algorithm is inspired from the echolocation behavior of bats combining the advantages of existing optimization techniques. A proper tuning of control parameter has been performed in order to achieve a balance between intensification and diversification phases. The proposed BA method for system identification is free from the problems encountered in conventional techniques. To valuate the performance of the proposed method, mean square error, mean square deviation and computation time are measured. Simulations have been carried out considering four benchmarked IIR systems using the same-order and reduced-order systems. The results of the proposed BA method have been compared to that of the well known optimization methods such as genetic algorithm, particle swarm optimization and cat swarm optimization. The simulation results confirm that the proposed system identification method outperforms the existing system identification methods.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3605–3617

A Multilevel Inverter with Reduced Power Switches

- Ebrahim Babaei, Sara Laali

Abstract

In this paper, a new basic 15-level inverter is proposed. Based on this inverter, a new 95-level inverter and a developed multilevel inverter are proposed. In addition, a new algorithm to determine the magnitude of dc voltage source of the basic unit is introduced. The proposed inverter is able to generate maximum number of output levels by using minimum number of power switches, driver circuits, IGBTs, power diodes and dc voltage sources. These advantages lead to decrease complexity, installation space and total cost of the inverter. These results are obtained by comparing the proposed inverter with several conventional multilevel inverters that have been presented in the literature. These comparisons are done in design of two multilevel inverters with minimum 15 levels and 95 levels at the output. Finally, the accuracy performance of the proposed inverter to generate all positive and negative levels at the output is reconfirmed through the experimental results on a 15-level inverter.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3619–3630

Fixed-Structure $H\infty$ Controller Design for Two-Rotor Aerodynamical System (TRAS)

- Mashhood Ahmad, Ahsan Ali, Mohammad Ahmad Choudhry

Abstract

This paper illustrates an efficient controller design technique for the control of a laboratory setup, known as two-rotor aerodynamical system (TRAS). A decentralized control of TRAS using control scheme known as fixed-structure $H\infty$ control is presented in this paper. TRAS is a multi-input–multi-output system having strong coupling between horizontal and vertical planes. The main focus of this paper is to design a reduced-order, robust controller for TRAS with a fixed structure. First, the nonlinear model is linearized and then system is decoupled into horizontal and vertical planes. Two independent SISO controllers are designed for both planes using proposed control approach. Comparison is made between conventional $H\infty$ and fixed-structure $H\infty$ controller design techniques under the influence of different command inputs. The performance of controllers under the effect of external disturbance is also taken into account to show the effectiveness of the proposed approach. In spite of having reduced order, the proposed approach has shown significant improvement toward tracking performance and disturbance rejection as compared to conventional $H\infty$ approach.

Arabian Journal for Science and Engineering (Arab J Sci Eng)

Research Article - Electrical Engineering
September 2016, Volume 41, Issue 9, pp 3631–3644

Delay Aware and Users Categorizing-Based Call Admission Control for Multi-Services LTE-A Networks

- Salman A. AlQahtani

Abstract

In this paper, we introduce the user's privileges and traffic maximum delay tolerance as additional dimensions in the call admission control processes to efficiently control the utilization of LTE-A network resources. Based on this idea, we propose an efficient call admission control scheme named "Delay Aware and User Categorizing-based CAC with Adaptive Resource Reservation", where the user priority is adjusted dynamically based on the current network conditions and the users' categorizations and traffic delay tolerances, to increase the network's resource utilization and at the same time to maximize the operators' revenue. In this proposed scheme, the users are classified into Golden users and Silver users, and the type of service per user is classified as real-time (RT) and non-real-time (NRT) services. We compare the performance of the proposed scheme with the corresponding results of previous schemes, referred to as the adaptive resource reservation-based Call Admission Control (ARR-CAC), where user categorization and delay were not taken into consideration in the call admission control process. Simulation results indicate the superiority of the proposed scheme because it is able to achieve a better balance between system utilization, users' privileges provided by network operators and QoS provisioning compared to the ARR-CAC scheme.

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Synthesis and Implementation of a Robust Fixed Low-Order Controller for Uncertain Systems

- Maher Ben Hariz, Faouzi Bouani

Abstract

Advancements in microelectronics and software allow the use of embedded systems in the implementation of some control laws. In this work, the STM32 microcontroller is exploited in order to implement a robust fixed low-order controller on an electronic system. Parametric uncertainty model is employed to describe the system behavior, and the controller objective is to guarantee some time response specifications in the presence of model uncertainties. The controller design is expressed as a min-max non-convex optimization problem while taking into account the desired closed-loop performances and uncertainties. Accordingly, with the aim of obtaining an optimal solution and then an optimal control law, the application of a global optimization method is recommended. In this work, the exploited global optimization method is the generalized geometric programming. The implementation of a proportional integral controller, a proportional integral derivative controller and the fixed low-order controller shows the efficiency of the latter one.

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Reconfigurable Bandwidth Antenna for LTE Application

- A. N. Obadiah, M. R. Hamid

Abstract

A reconfigurable bandwidth antenna is proposed. A Vivaldi antenna is used in the design due to its wideband capability, moderate high gain and symmetrical radiation patterns in the E and H planes. To vary the frequency bandwidth of the Vivaldi, two pairs of resonator rings have been integrated along the elliptically shaped slot line. The resonator rings are deactivated or activated with the aid of switches to yield either a wideband frequency of 1–2.8 GHz or two narrower frequencies with different bandwidths at 2.6 GHz, respectively. This principle of bandwidth reconfigurability can be potentially put into use in OFDMA-related applications such as LTE since there are multiple sub-carriers which are aggregated based on the rate needs of the user at each instance ranging from 1.4 to 20 MHz. The simulation results are obtained using CST microwave studio, and the results show good agreement with the measured results.