Soft robotic gripper with compliant cell stacks for industrial part handling

Robot object grasping and handling requires accurate grasp pose estimation and gripper/end-effector design, tailored to individual objects. When object shape is unknown, cannot be estimated, or is highly complex, parallel grippers can provide insufficient grip. Compliant grippers can circumvent these issues through the use of soft or flexible materials that adapt to the shape of the object. This letter proposes a 3D printable soft gripper design for handling complex shapes. The compliant properties of the gripper enable contour conformation, yet offer tunable mechanical properties (i.e., directional stiffness). Objects that have complex shape, such as non-constant curvature, convex and/or concave shape can be grasped blind (i.e., without grasp pose estimation). The motivation behind the gripper design is handling of industrial parts, such as jet and Diesel engine components. (Dis)assembly, cleaning and inspection of such engines is a complex, manual task that can benefit from (semi-)automated robotic handling. The complex shape of each component, however, limits where and how it can be grasped. The proposed soft gripper design is tunable by compliant cell stacks that deform to the shape of the handled object. Individual compliant cells and cell stacks are characterized and a detailed experimental analysis of more than 600 grasps with seven different industrial parts evaluates the approach.

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Contributors: Netzev, M., Angleraud, A., Pieters, R.
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Source ID: 85091134388
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Analog Mitigation of Frequency-Modulated Interference for Improved GNSS Reception

Powerful in-band interference can saturate a receiver's front-end and limit the usefulness of digital interference suppression methods that are bounded by the receiver's limited dynamic range. This is especially true for the self-interference (SI) encountered in full-duplex (FD) radios, but also in the case of strong interference between co-located radios. However, unlike in FD radios, receivers co-located with interference sources do not typically have direct access to the transmitted interference. This work analyzes the performance of a digitally-assisted analog interference mitigation method and its implementation for the suppression of frequency-modulated (FM) interference before quantization in global navigation satellite system (GNSS) receivers that are co-located with interference sources. Over-the-air measurement results are presented that illustrate the effects of interference mitigation on GPS L1 and Galileo E1 reception in a commercial off-the-shelf GNSS receiver and a software-defined GNSS receiver. The analysis covers the effects of the interference mitigation on the radio frequency (RF) front-end, acquisition, tracking, and positioning stages.

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Contributors: Parlin, K., Riihonen, T.
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Modeling and Mitigating 5G Wireless Downlink Interferences for Low-altitude Aerial vehicles
Future 5G networks will serve both terrestrial and aerial users, thanks to their network slicing and flexible numerology capabilities. The probability of Line-of-Sight (LoS) propagation will be intuitively higher for aerial users than for terrestrial users and this will provide a trade-off between increased capacity and increased interference. Our paper analyzes theoretically this trade-off and proposes solutions based on downlink multiantenna beamorming and joint optimization of the signal-to- interference ratio of multiple aerial users. It is shown that Multiple-Input-Single-Output solutions offer the most convenient tradeoff between complexity and capacity/interference performance. Simulation results are provided for mm Wave bands and low-altitude aerial vehicles.

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Positioning Based on Noise-Limited Censored Path Loss Data
Positioning is considered one of the most important features and enabler of various novel industry verticals in future radio systems. Since path loss or received signal strength-based measurements are widely available and accessible in the majority of wireless standards, path loss-based positioning has an important role among other positioning technologies. Conventionally path loss-based positioning has two phases; i) fitting a path loss model to training data, if such training data is available, and ii) determining link distance estimates based on the path loss model and calculating the position estimate. However, in both phases, the maximum measurable path loss is limited by measurement noise. Such immeasurable samples are called censored path loss data and such noisy data is commonly neglected in both the model fitting and in the positioning phase. In the case of censored path loss, the loss is known to be above a known threshold level and that information can be used in model fitting as well as in the positioning phase. In this paper, we examine and propose how to use censored path loss data in path loss model-based positioning and demonstrate with simulations the potential of the proposed approach for considerable improvements (over 30%) in positioning accuracy.

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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Radio-based Sensing and Indoor Mapping with Millimeter-Wave 5G NR Signals
The emerging 5G New Radio (NR) networks are expected to enable huge improvements, e.g., in terms of capacity, number of connected devices, peak data rates and latency, compared to existing networks. At the same time, a new trend referred to as the RF convergence is aiming to jointly integrate communications and sensing functionalities into the same systems and hardware platforms. In this paper, we investigate the sensing prospects of 5G NR systems, with particular emphasis on the user equipment side and their potential for joint communications and environment mapping. To this end, a radio-based sensing approach utilizing the 5G NR uplink transmit signal and an efficient receiver processing and mapping scheme are proposed. An indoor scenario is then studied and evaluated through real-world RF measurements at 28 GHz mm-wave band, showing that impressive mapping performance can be achieved by the proposed system. The measurement data is available at a permanent open repository.

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Contributors: Barneto, C. B., Riihonen, T., Turunen, M., Koivisto, M., Talvitie, J., Valkama, M.
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Operation of a PV power plant during overpower events caused by the cloud enhancement phenomenon

Partly cloudy days possess two characteristics that can significantly increase the photovoltaic (PV) generator power: the operating temperature of the PV panels can cool down during the shade periods, and the irradiance can be enhanced due to the cloud enhancement phenomenon. If an overirradiance event is preceded by a long shade period, the maximum power of a PV generator can occasionally be much higher than the nominal nameplate power. During the overpower events, the inverter is operating in power-limiting mode whereby the operating voltage is increased to decrease the power of the PV generator. We created a simulation model of a 31.9 kW PV generator and used 12 months of irradiance and PV panel temperature measurement data to analyze its operation. We analyzed the PV generator power during the overirradiance events and applied various static power limits to calculate the operating voltage ranges in case of power curtailment. During the observation period, the maximum power produced by the PV generator was 1.42 times its nominal power. The duration of the overpower events was up to several minutes, but the typical duration was only some tens of seconds. The strongest overpower events occur seldom and their duration is only some seconds. Due to the overpower events, the operating voltage may receive high values, especially if the DC-to-AC power ratio is large.

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Contributors: Järvelä, M., Valkealahti, S.
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Assessing and comparing short term load forecasting performance

When identifying and comparing forecasting models, there may be a risk that poorly selected criteria could lead to wrong conclusions. Thus, it is important to know how sensitive the results are to the selection of criteria. This contribution aims to study the sensitivity of the identification and comparison results to the choice of criteria. It compares typically applied criteria for tuning and performance assessment of load forecasting methods with estimated costs caused by the forecasting errors. The focus is on short-term forecasting of the loads of energy systems. The estimated costs comprise electricity market costs and network costs. We estimate the electricity market costs by assuming that the forecasting errors cause balancing errors and consequently balancing costs to the market actors. The forecasting errors cause network costs by overloading network components thus increasing losses and reducing the component lifetime or alternatively increase operational margins to avoid those overloads. The lifetime loss of insulators, and thus also the components, is caused by heating according to the law of Arrhenius. We also study consumer costs. The results support the assumption that there is a need to develop and use additional and case-specific performance criteria for electricity load forecasting.

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Contributors: Koponen, P., Ikäheimo, J., Koskela, J., Brester, C., Niska, H.

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Source ID: 85084049691
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Effect of energy recovery on efficiency in electro-hydrostatic closed system for differential actuator
This paper investigates energy efficiency and dynamic behavior through simulation and experiments of a compact electro-hydrostatic actuator system (EHA) consisting of an electric motor, external gear pump/motors, hydraulic accumulator, and differential cylinder. Tests were performed in a stand-alone crane in order to validate the mathematical model. The influence and importance of a good balance between pump/motors displacement and cylinder areas ratios is discussed. The overall efficiency for the performed motion is also compared considering the capability or not of energy recovery. The results obtained demonstrate the significant gain of efficiency when working in the optimal condition and it is compared to the conventional hydraulic system using proportional valves. The proposed system presents the advantages and disadvantages when utilizing components off-the-shelf taking into account the applicability in mobile and industrial stationary machines.

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Organisations: Automation Technology and Mechanical Engineering, Federal University of Santa Catarina, Innovative Hydraulics and Automation Research Group, Aalto University
Contributors: Agostini, T., Negri, V. D., Minav, T., Pietola, M.
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Practical implementation of adaptive SRF-PLL for three-phase inverters based on sensitivity function and real-time grid-impedance measurements
Rapidly increasing demand for renewable energy has created a need for the photovoltaic and wind farms to be placed in various locations that have diverse and possibly time-variant grid conditions. A mismatch between the grid impedance and output admittance of an inverter causes impedance-based stability issues, which appear as power quality problems and poor transient performance. Grid synchronization with phase-locked loop (PLL) introduces a negative-resistance-like behavior to inverter output admittance. High control bandwidth of the PLL makes the system sensitive to impedance-

based stability issues when the inverter is connected to a weak grid that has high impedance. However, very conservative tunings lead to overly damped dynamic responses in strong grids, where the control performance and power quality can be improved by applying higher PLL control bandwidths. Continuous evaluation of grid conditions makes it possible to avoid the risk of instability and poor dynamic responses, as the inverter output admittance can be re-shaped online to continuously match the grid conditions. The present work proposes method for adaptive control of the PLL based on the real-time measurements of the grid impedance, applying pseudo-random binary sequence (PRBS) injections. The method limits the PLL bandwidth in weak grids to avoid stability issues and increases the control bandwidth in strong grids to improve voltage-tracking, and thus overall control performance. The method is verified through simulations and experimental laboratory tests in a kW-scale system. The results show that optimizing the PLL bandwidth with respect to the grid conditions is highly beneficial for system performance and stability.

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Contributors: Luhtala, R., Alenius, H., Roinila, T.
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Research output: Contribution to journal › Article › Scientific › peer-review

Adjoint-based optimization in the development of low-emission industrial boilers
A gradient-based method has been developed and programmed to optimize the NH (Formula presented.) injections of an existing biomass-fired bubbling fluidized bed boiler, the targets being to minimize both the NO and the NH (Formula presented.) emissions. In this context, the reactive flow inside the boiler is modelled using a custom-built OpenFOAM (Formula presented.) solver, and then the NO and NH (Formula presented.) species are calculated using a post-processing technique. The multiobjective optimization problem is solved by optimizing several weight combinations of the objectives using the gradient-projection method. The required sensitivities were calculated by differentiating the post-processing solver according to the discrete adjoint method. The adjoint-based sensitivities are validated against finite differences calculations. Moreover, in order to evaluate the optimization results, the optimization problem is solved using evolutionary algorithms software. Finally, the optimization results are physically interpreted and the strengths and weaknesses of the proposed method are discussed.

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Censor-Based Cooperative Multi-Antenna Spectrum Sensing with Imperfect Reporting Channels

The present contribution proposes a spectrally efficient censor-based cooperative spectrum sensing (C-CSS) approach in a sustainable cognitive radio network that consists of multiple antenna nodes and experiences imperfect sensing and reporting channels. In this context, exact analytic expressions are first derived for the corresponding probability of detection, probability of false alarm, and secondary throughput, assuming that each secondary user (SU) sends its detection outcome to a fusion center only when it has detected a primary signal. Capitalizing on the findings of the analysis, the effects of critical measures, such as the detection threshold, the number of SUs, and the number of employed antennas, on the overall system performance are also quantified. In addition, the optimal detection threshold for each antenna based on the Neyman-Pearson criterion is derived and useful insights are developed on how to maximize the system throughput with a reduced number of SUs. It is shown that the C-CSS approach provides two distinct benefits compared with the conventional sensing approach, i.e., without censoring: i) the sensing tail problem, which exists in imperfect sensing environments, can be mitigated; and ii) less SUs are ultimately required to obtain higher secondary throughput, rendering the system more sustainable.

General information

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Organisations: Research group: Wireless Communications and Positioning, Electrical Engineering, Taiyuan University of Science and Technology, University of Waterloo, Khalifa University, University of Surrey, University of London, Simon Fraser University
Contributors: Li, M., Alhussein, O., Sofotasios, P. C., Muhaidat, S., Yoo, P. D., Liang, J., Wang, A.
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Charlie and the CryptoFactory: Towards Secure and Trusted Manufacturing Environments

The modernization that stems from Industry 4.0 started populating the manufacturing sector with networked devices, complex sensors, and a significant proportion of physical actuation components. However, new capabilities in networked cyber-physical systems demand more complex infrastructure and algorithms and often lead to new security flaws and operational risks that increase the attack surface area exponentially. The interconnected nature of Industry 4.0-driven operations and the pace of digital transformation mean that cyberattacks can have far more extensive effects than ever before. Based on that, the core ideas of this paper are driven by the observation that cybersecurity is one of the key enablers of Industry 4.0. Having this in mind, we propose CryptoFactory - a forward-looking design of a layered-based architecture that can be used as a starting point for building secure and privacy-preserving smart factories. CryptoFactory aims to change the security outlook in smart manufacturing by discussing a set of fundamental requirements and functionality that modern factories should support in order to be resistant to both internal and external attacks. To this end, CryptoFactory first focuses on how to build trust relationships between the hardware devices in the factory. Then, we look on how to use several cryptographic approaches to allow IoT devices to securely collect, store and share their data while we also touch upon the emerging topic of secure and privacy-preserving communication and collaboration between

manufacturing environments and value chains. Finally, we look into the problem of how to perform privacy-preserving analytics by leveraging Trusted Execution Environments and the promising concept of Functional Encryption.

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Contributors: Michalas, A., Kiss, T.
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Comparative energy analysis of a load sensing system and a zonal hydraulics for a 9-tonne excavator
With the rising demand for energy efficiency, displacement-controlled or so-called pumpcontrolled systems have become an attractive research topic for applications in construction machinery and other off-road vehicles. Pump-controlled systems can be implemented with electro-hydrostatic actuators as electro-hydraulic zones, which are located next to the end actuator as a replacement for the traditional valve-controlled hydraulic actuation systems. In this paper a 9-tonne class excavator is utilized as a study case. A mathematical model of the conventional machine, validated with tests carried out on both the excavator and the single hydraulic components, was previously developed within the Simcenter AMESim

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Contributors: Casoli, P., Scolari, F., Minav, T., Rundo, M.
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Research output: Contribution to journal › Article › Scientific › peer-review

Comparing capacity gains of static and UAV-based millimeter-wave relays in clustered deployments

The prospective millimeter-wave (mmWave) networks are envisioned to heavily utilize relay nodes to improve their performance in certain scenarios. In addition to the stationary mmWave relays already considered by 3GPP as one of the main focuses, the community recently started to explore the use of unmanned aerial vehicle (UAV)-based mmWave relays. These aerial nodes provide greater flexibility in terms of the relay placement in different environments as well as the ability to optimize the deployment height thus maximizing the cell performance. At the same time, the use of UAV-based relays leads to additional deployment complexity and expenditures for the network operators. In this paper, taking into account 3GPP-standardized mmWave-specific propagation, blockage, and resource allocation we compare the capacity gains brought by the static and the UAV-based mmWave relays in different scenarios. For each of the relay types, we investigate both uniform and clustered distribution of human users. The developed mathematical framework and a numerical study reveal that the highest capacity gains when utilizing the UAV-based relays instead of the static ones are observed in clustered deployments (up to 31%), while the performance difference between the UAV-based and the static mmWave relays under a uniform distribution of users is just 3%.

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Contributors: Gapeyenko, M., Petrov, V., Moltchanov, D., Yeh, S. P., Himayat, N., Andreev, S.
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Source ID: 85090293224
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Constrained PSK: Energy-efficient modulation for Sub-THz systems

Deploying sub-THz frequencies for mobile communications is one timely research area, due to the availability of very wide and contiguous chunks of the radio spectrum. However, at such extremely high frequencies, there are large challenges related to, e.g., phase noise, propagation losses as well as to energy-efficiency, since generating and radiating power with reasonable efficiency is known to be far more difficult than at lower frequencies. To address the energy-efficiency and power amplifier (PA) nonlinear distortion related challenges, modulation methods and waveforms with low peak-to-average-power ratio (PAPR) are needed. To this end, a new modulation approach is formulated and proposed in this paper, referred to as constrained phase-shift keying (CPSK). The CPSK concept builds on the traditional PSK constellations, while additional constraints are applied to the time domain symbol transitions in order to control and reduce the PAPR of the resulting waveform. This new modulation is then compared with pulse-shaped π/2-BPSK and ordinary QPSK, in the discrete Fourier transform (DFT) spread orthogonal frequency division multiplexing (DFT-s-OFDM) context, in terms of the resulting PAPR distributions and the achievable maximum PA output power, subject to constraints in the

passband waveform quality and out-of-band emissions. The obtained results show that the proposed CPSK approach allows for reducing the PAPR and thereon for achieving higher PA output powers, compared to QPSK, while still offering the same spectral efficiency. Overall, the CPSK concept offers a flexible modulation solution with controlled PAPR for the future sub-THz networks.

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Organisations: Electrical Engineering, Research group: Wireless Communications and Positioning
Contributors: Nasarre, I. P., Levanen, T., Valkama, M.
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ASJC Scopus subject areas: Artificial Intelligence, Computer Networks and Communications, Signal Processing, Information Systems and Management, Control and Optimization
Keywords: 5G New Radio (NR) evolution, DFT-s-OFDM, Energy-efficiency, Modulation, PAPR, Power amplifiers, Sub-THz communications
DOIs:
10.1109/ICCWorkshops49005.2020.9145132

Bibliographical note
JUFOID=88220
Source: Scopus
Source ID: 85090293993
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Introducing Multi-Convexity in Path Constrained Trajectory Optimization for Mobile Manipulators
Mobile manipulators have a highly non-linear and non-convex mapping between the end-effector path and the manipulator's joints and position and orientation of the mobile base. As a result, trajectory optimization with end-effector path constraints takes the form of a difficult non-linear optimization problem. In this paper, we present the first multi-convex approximation to this difficult optimization problem that eventually reduces to solving a sequence of globally valid convex quadratic programs (QPs). The proposed optimizer rests on two novel building blocks. First, we introduce a set of auxiliary variables in which the non-linear constraints that arise out of manipulator kinematics and its coupling with the mobile base have a multi-affine form. Projecting the auxiliary variables to the space of actual configuration variables of the mobile manipulator involves a non-convex optimization. Thus, the second building block involves computing a convex surrogate for this non-convex projection. We show how large parts of the proposed optimizer can be solved in parallel providing the possibility of exploiting multi-core CPUs. We validate our trajectory optimization on different benchmark examples. Specifically, we highlight how it solves the cyclicity problem and provides a holistic approach where a diverse set of trajectories can be obtained by trading-off different aspects of manipulator and mobile base motion.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation Technology and Mechanical Engineering, Research group: Robotics and Automation, University of Tartu, Johannes Kepler University
Contributors: Singh, A. K., Ahonen, A., Ghabcheloo, R., Mueller, A.
Number of pages: 8
Pages: 1178-1185
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ASJC Scopus subject areas: Artificial Intelligence, Decision Sciences (miscellaneous), Control and Systems Engineering, Mechanical Engineering, Computational Mathematics, Control and Optimization

Bibliographical note
EXT="Singh, Arun Kumar"
Source: Scopus
Source ID: 85090156821
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Multi-sensor next-best-view planning as matroid-constrained submodular maximization
3D scene models are useful in robotics for tasks such as path planning, object manipulation, and structural inspection. We consider the problem of creating a 3D model using depth images captured by a team of multiple robots. Each robot selects a viewpoint and captures a depth image from it, and the images are fused to update the scene model. The process is repeated until a scene model of desired quality is obtained. Next-best-view planning uses the current scene model to select the next viewpoints. The objective is to select viewpoints so that the images captured using them improve the quality of the scene model the most. In this letter, we address next-best-view planning for multiple depth cameras. We propose a utility function that scores sets of viewpoints and avoids overlap between multiple sensors. We show that multi-sensor next-best-view planning with this utility function is an instance of submodular maximization under a matroid constraint. This allows the planning problem to be solved by a polynomial-Time greedy algorithm that yields a solution within a constant factor from the optimal. We evaluate the performance of our planning algorithm in simulated experiments with up to 8 sensors, and in real-world experiments using two robot arms equipped with depth cameras.

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MoE publication type: A1 Journal article-refereed
Organisations: Computing Sciences, Technical University Darmstadt, Max Planck Institute for Intelligent Systems, University of Hamburg
Contributors: Lauri, M., Pajarinen, J., Peters, J., Frintrop, S.
Number of pages: 8
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ASJC Scopus subject areas: Control and Systems Engineering, Biomedical Engineering, Human-Computer Interaction, Mechanical Engineering, Computer Vision and Pattern Recognition, Computer Science Applications, Control and Optimization, Artificial Intelligence
Keywords: multi-robot systems, Reactive and sensor-based planning, RGB-D perception
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10.1109/LRA.2020.3007445

Bibliographical note
EXT="Lauri, Mikko"
Source: Scopus
Source ID: 85090245712
Research output: Contribution to journal › Article › Scientific › peer-review

Probabilistic approach to physical object disentangling
Physically disentangling entangled objects from each other is a problem encountered in waste segregation or in any task that requires disassembly of structures. Often there are no object models, and especially with cluttered irregularly shaped objects, the robot cannot create a model of the scene due to occlusion. One of our key insights is that based on previous sensory input we are only interested in moving an object out of the disentanglement around obstacles. That is, we only need to know where the robot can successfully move in order to plan the disentangling. Due to the uncertainty we integrate information about blocked movements into a probability map. The map defines the probability of the robot successfully moving to a specific configuration. Using as cost the failure probability of a sequence of movements we can then plan and execute disentangling iteratively. Since our approach circumvents only previously encountered obstacles, new movements will yield information about unknown obstacles that block movement until the robot has learned to circumvent all obstacles and disentangling succeeds. In the experiments, we use a special probabilistic version of the Rapidly exploring Random Tree (RRT) algorithm for planning and demonstrate successful disentanglement of objects both in 2-D and 3-D simulation, and, on a KUKA LBR 7-DOF robot. Moreover, our approach outperforms baseline methods.

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Organisations: Computing Sciences, Technical University Darmstadt, University of Lincoln, Max Planck Institute for Intelligent Systems
Contributors: Pajarinen, J., Arenz, O., Peters, J., Neumann, G.
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ASJC Scopus subject areas: Control and Systems Engineering, Biomedical Engineering, Human-Computer Interaction, Mechanical Engineering, Computer Vision and Pattern Recognition, Computer Science Applications, Control and Optimization, Artificial Intelligence
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Source: Scopus
Source ID: 85090290264
Research output: Contribution to journal › Article › Scientific › peer-review

Reinforcement learning for improved UAV-based integrated access and backhaul operation
There is a strong interest in utilizing commercial cellular networks to support unmanned aerial vehicles (UAVs) to send control commands and communicate heavy traffic. Cellular networks are well suited for offering reliable and secure connections to the UAVs as well as facilitating traffic management systems to enhance safe operation. However, for the full-scale integration of UAVs that perform critical and high-risk tasks, more advanced solutions are required to improve wireless connectivity in mobile networks. In this context, integrated access and backhaul (IAB) is an attractive approach for the UAVs to enhance connectivity and traffic forwarding. In this paper, we study a novel approach to dynamic associations based on reinforcement learning at the edge of the network and compare it to alternative association algorithms. Considering the average data rate, our results indicate that the reinforcement learning methods improve the achievable data rate. The optimal parameters of the introduced algorithm are highly sensitive to the donor next generation node base (DgNB) and UAV IAB node densities, and need to be identified beforehand or estimated via a stateful search. However, its performance nearly converges to that of the ideal scheme with a full knowledge of the data rates in dense deployments of DgNBs.

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Organisations: Electrical Engineering, Research group: Emerging Technologies for Nano-Bio-Info-Cogno, Research group: Wireless Communications and Positioning, Intel Corporation
Contributors: Tafintsev, N., Moltchanov, D., Simsek, M., Yeh, S. P., Andreev, S., Koucheryavy, Y., Valkama, M.
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JUFOID=88220
Source: Scopus
Source ID: 85090294995
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Resilient Cooperative Voltage Control for Distribution Network with High Penetration Distributed Energy Resources
This paper considers the problem of designing a resilient distributed voltage control algorithm for distribution systems with high penetration of distributed energy resources in the presence of an unknown cyber-attack. The purpose of the attack is to force the system to violate the operating voltage limit by intercepting its communication channels and inserting exogenous signals to perturb and/or modify the information being exchanged. We first review the cooperative voltage control proposed in our previous work and provide a new stability analysis for it. Next, we present a resilient cooperative voltage control algorithm by introducing a virtual system interconnected with the original system such that the voltage can be maintained within the operational limit under unknown attacks. The resiliency of the proposed algorithm is demonstrated via simulations on the IEEE 8500-node system when subjected to an attack which consists of corrupting the data being exchanged in the communication network between two generation units.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation Technology and Mechanical Engineering, University of Central Florida
Contributors: Gusrialdi, A., Xu, Y., Qu, Z., Simaan, M. A.
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Publication date: 2020

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ASJC Scopus subject areas: Artificial Intelligence, Decision Sciences (miscellaneous), Control and Systems Engineering, Mechanical Engineering, Computational Mathematics, Control and Optimization
Keywords: cooperative control, cyber attacks, distribution network, resilient control, Voltage control
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Joint Sparse Recovery of Misaligned Multimodal Images via Adaptive Local and Nonlocal Cross-Modal Regularization
Given few noisy linear measurements of distinct misaligned modalities, we aim at recovering the underlying multimodal image using a sparsity promoting algorithm. Unlike previous multimodal sparse recovery approaches employing side information under the naive assumption of perfect calibration of modalities or of known deformation parameters, we adaptively estimate the deformation parameters from the images separately recovered from the incomplete measurements. We develop a multiscale dense registration method that proceeds alternately by finding block-wise intensity mapping models and a shift vector field which is used to obtain and refine the deformation parameters through a weighted least-squares approximation. The co-registered images are then jointly recovered in a plug-and-play framework where a collaborative filter leverages the local and nonlocal cross-modal correlations inherent to the multimodal image. Our experiments with this fully automatic registration and joint recovery pipeline show a better detection and sharper recovery of fine details which could not be separately recovered.

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Contributors: Eslahi, N., Foi, A.
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URLs:

http://urn.fi/URN:NBN:fi:tuni-202005115149
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Towards the EU emission targets of 2050: Cost-effective emission reduction in Finnish detached houses
To mitigate the effects of climate change, the European Union calls for major carbon emission reductions in the building sector through a deep renovation of the existing building stock. This study examines the cost-effective energy retrofit measures in Finnish detached houses. The Finnish detached house building stock was divided into four age classes according to the building code in effect at the time of their construction. Multi-objective optimization with a genetic algorithm was used to minimize the life cycle cost and CO_2 emissions in each building type for five different main heating systems (district heating, wood/oil boiler, direct electric heating, and ground-source heat pump) by improving the building envelope and systems. Cost-effective emission reductions were possible with all heating systems, but especially with ground-source heat pumps. Replacing oil boilers with ground-source heat pumps (GSHPs), emissions could be reduced by 79% to 92% across all the studied detached houses and investment levels. With all the other heating systems, emission reductions of 20% to 75% were possible. The most cost-effective individual renovation measures were the installation of air-to-air heat pumps for auxiliary heating and improving the thermal insulation of external walls.

General information
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MoE publication type: A1 Journal article-refereed
Organisations: Civil Engineering, Research group: Responsible Construction, Aalto University
Contributors: Hirvonen, J., Jokisalo, J., Heljo, J., Kosonen, R.
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Keywords: Deep renovation, Detached house, Energy retrofit, Genetic algorithm, Greenhouse gas emissions, Heat pump, Multi-objective optimization
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Source: Scopus
Source ID: 85076020206
Research output: Contribution to journal › Article › Scientific › peer-review

FORMI: A Fast Holonomic Path Planning and Obstacle Representation Method Based on Interval Analysis
This paper presents a path planning approach for mobile robots in 2D spaces. The algorithm uses a quadtree decomposition where the discretization precision is improved until a path to the goal is found if one exists. The algorithm uses interval analysis-based methods to categorize the quadtree decomposition to occupied, free and partly occupied cells. The proposed algorithm is compared against other concurrent path planning algorithms, A on an ordinary quadtree,

A for shortest path on a binary occupancy grid, and a Dijkstra's algorithm for lowest collision probability in a continuous-valued occupancy grid, in five different scenarios.Compared to the other methods, the main advantage of our method is achieving a compromise between driving distance, safety, and computation time. The proposed algorithm was found to require significantly fewer collision checks in all scenarios while providing sub-optimum results, based on the obstacle distance and path length criteria. The algorithm is suitable for further extension to include non-euclidean measures and for higher dimensions of configuration spaces. The proposed algorithm will be publicly available on GitHub repository.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation Technology and Mechanical Engineering, Research group: Innovative Hydraulic Automation
Contributors: Mäenpää, P., Aref, M. M., Mattila, J.
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Position Estimation for Drones based on Visual SLAM and IMU in GPS-denied Environment

Due to the increased rate of drone usage in various commercial and industrial fields, the need for their autonomous operation is rapidly increasing. One major aspect of autonomous movement is the ability to operate safely in an unknown environment. The majority of current works are persistently using a global positioning system (GPS) to directly find the absolute position of the drone. However, GPS accuracy might be not suitable in some applications and this solution is not applicable to all situations. In this paper, a positioning system based on monocular SLAM and inertial measurement unit (IMU) is presented. The position is calculated through the semi-direct visual odometry (SVO) method alongside IMU data, and is integrated with an extended Kalman filter (EKF) to enhance the efficiency of the algorithm. The data is then employed to control the drone without any requirement to any source of external input. The experiment results for long-distance flying paths is very promising.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Computing Sciences, K. N. Toosi University of Technology
Contributors: Motlagh, H. D. K., Lotfi, F., Taghirad, H. D., Germi, S. B.
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ASJC Scopus subject areas: Artificial Intelligence, Computer Science Applications, Electrical and Electronic Engineering, Mechanical Engineering, Control and Optimization, Instrumentation
Keywords: Kalman filtering, monocular camera, Position estimation, SLAM, UAV

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Maximum perturbation step size in MPP-Tracking control for ensuring predicted PV power settling behavior

The heuristic perturb-and-observe-based maximum-power-point tracking (MPPT) algorithm of photovoltaic (PV) generator is still the most popular technique in use, despite the broad spectrum of developed other MPPT algorithms. The correct direction of the next perturbation step requires that the previous perturbation is settled down properly and the applied perturbation step size is large enough to overcome the PV-power changes induced by the varying irradiation level and/or the power-grid-originated PV-voltage ripple. The requirements for the minimum perturbation step size are well defined in the available literature. The design equations to predict the PV-power settling time are derived by assuming that the PV-interfacing converter operates in continuous conduction mode (CCM). A large perturbation step size may drive the interfacing converter to enter into discontinuous conduction mode (DCM), which will delay the PV-power settling process and destroy the validity of the predicted settling times. In order to avoid confusing the MPPT process, the maximum perturbation step size has to be limited as well. This paper provides theoretical foundations for the proper design of the maximum step size based on the DC-DC interfacing-converter dynamic behavior. The theoretical findings are validated with experiments as well as by simulations by means of a boost-type DC-DC converter and real PV panel.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Electrical Engineering, Research group: Power electronics, Research area: Power engineering, Ben-Gurion University of the Negev
Contributors: Suntio, T., Kuperman, A.
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Original language: English
ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering
Keywords: MPP tracking, Perturbation step size, PV generator, Transient settling time
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URLs:
http://urn.fi/URN:NBN:fi:tuni-201912126795
Source: Scopus
Source ID: 85075001066
Research output: Contribution to journal › Article › Scientific › peer-review

Visibility-Aware Part Coding for Vehicle Viewing Angle Estimation

A number of spatially-localised semantic parts of vehicles sensitive to pose changes are encoded their visible probabilities into a mid-level feature vector. Car pose estimation is then formulated into a regression on concatenated low-and mid-level features to continuously changing viewing angles. Each dimension of our visibility-Aware part codes separates all the training samples into two groups according to its visual existence in images, which provides additional part-specific range constraint of viewing angles. Moreover, the proposed codes can alleviate the suffering from sparse and imbalanced data distribution in the light of modelling latent dependency across angle targets. Experimental evaluation for car pose estimation on the EPFL Multi-View Car benchmark demonstrates significant improvement of our method over the state-of-The-Art regression methods, especially when only sparse and imbalanced data is available.

General information

Publication status: Published

MoE publication type: A4 Article in a conference publication
Organisations: Computing Sciences, Research group: Vision, South China University of Technology
Contributors: Yang, D., Qian, Y., Cai, D., Yan, S., Kämäräinen, J., Chen, K.
Number of pages: 6
Pages: 65-70
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Keywords: Car pose estimation, Coding, Pose-sensitive parts, Regression forests, Visibility-Aware
DOIs:

10.1109/ICIST.2019.8836907

Bibliographical note
EXT="Chen, Ke"
jufoid=79229
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Blockchain Technology for Smartphones and Constrained IoT Devices: A Future Perspective and Implementation
The blockchain technology is currently penetrating different sides of modern ICT community. Most of the devices involved in blockchain-related processes are specially designed targeting only the mining aspect. At the same time, the use of wearable and mobile devices may also become a part of blockchain operation, especially during the charging time. The paper considers the possibility of using a large number of constrained devices supporting the operation of the blockchain. The utilization of such devices is expected to improve the efficiency of the system and also to attract a more substantial number of users. Authors propose a novel consensus algorithm based on a combination of Proof-of-Work (PoW), Proof-of-Activity (PoA), and Proof-of-Stake (PoS). The paper first overviews the existing strategies and further describes the developed cryptographic primitives used to build a blockchain involving mobile devices. A brief numerical evaluation of the designed system is also provided in the paper.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Electrical Engineering, Enecuum HK Limited, ITMO University, St. Petersburg State University of Telecommunication
Contributors: Zhidanov, K., Bezzateev, S., Afanasyeva, A., Sayfullin, M., Vanurin, S., Bardinova, Y., Ometov, A.
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ASJC Scopus subject areas: Business, Management and Accounting (miscellaneous), Management Information Systems , Hardware and Architecture, Information Systems, Information Systems and Management, Control and Optimization
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Bibliographical note
EXT="Zhidanov, Konstantin"
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Approximate Controllability for Navier–Stokes Equations in 3D Rectangles Under Lions Boundary Conditions

The 3D Navier–Stokes system, under Lions boundary conditions, is proven to be approximately controllable provided a suitable saturating set does exist. An explicit saturating set for 3D rectangles is given.

General information

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MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Johann Radon Institute for Computational and Applied Mathematics
Contributors: Phan, D., Rodrigues, S. S.
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Keywords: Approximate controllability, Navier–Stokes equations, Saturating set
DOIs:

10.1007/s10883-018-9412-0
Source: Scopus
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Research output: Contribution to journal › Article › Scientific › peer-review

Automatic numerical differentiation by maximum likelihood estimation of a linear Gaussian state space model

A linear Gaussian state-space smoothing algorithm is presented for off-line estimation of derivatives from a sequence of noisy measurements. The algorithm uses numerically stable square-root formulas, can handle simultaneous independent measurements and non-equally spaced abscissas, and can compute state estimates at points between the data abscissas. The state space model's parameters, including driving noise intensity, measurement variance, and initial state, are determined from the given data sequence using maximum likelihood estimation computed using an expectation maximisation iteration. In tests with synthetic biomechanics data, the algorithm is found to be more accurate compared to a widely used open source automatic numerical differentiation algorithm, especially for acceleration estimation.

General information

Publication status: Published
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Organisations: Computing Sciences
Contributors: Piche, R.
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Publication date: 1 Jun 2019

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ASJC Scopus subject areas: Instrumentation, Control and Optimization
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http://urn.fi/URN:NBN:fi:tuni-201910304221
Source: Scopus
Source ID: 85071535987
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Composite nonlinear feedback control of a JIB trolley of a tower cranebehaviors

Cranes are required to lift and carry loads swiftly to desired positions without causing excessive swaying motion of the load. These are conflicting requirements, which make feedback control of crane systems challenging. Furthermore, variations in rope length and load mass complicate controller design, since they significantly influence swaying dynamics. This paper considers automatic control of Quanser 3DOF tower crane system using composite nonlinear feedback (CNF) methodology. To be more specific, a CNF controller is designed for the jib trolley position of the crane using partial state measurements. The performance of the CNF controller is compared with Quanser's built-in linear quadratic regulator (LQR) controller both in simulation and experimental setups. The results show that the CNF controller provides better load handling capability in terms of fast positioning of the jib trolley and damping of load swaying.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation Technology and Mechanical Engineering, Research group: Automation and Systems Theory
Contributors: Pyrhönen, V., Vilkko, M. K.
Number of pages: 6
Pages: 1124-1129
Publication date: 1 Jun 2019

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Publisher: IEEE
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ASJC Scopus subject areas: Instrumentation, Control and Optimization
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Fabrication of soft devices with buried fluid channels by using sacrificial 3D printed molds

Casting silicone elastomers into 3D printed molds has seen a surge of applications in soft robots, soft manipulators, microfluidics, wearable technologies and stretchable sensors. In such devices, buried fluid channels are used to transport fluids, as fluidic actuators and as sensors with liquid metal. However, it is difficult to demold structures with buried channels or overhangs. As a solution, using sacrificial molds made of dissolvable materials has been proposed. In this paper, we evaluate different commercially available 3D printing materials as dissolvable mold materials. We tested dissolving prints made of high-impact polystyrene (HIPS), acrylonitrile butadiene styrene (ABS), polyvinyl butyral (PVB) and polyvinyl alcohol (PVA) in limonene, acetone, isopropanol/ethanol and water, respectively. We further studied the effect of magnetic stirring and ultrasonic bath on the dissolution times. Finally, we fabricated buried channels using different mold materials and silicone elastomers. The results show that at least ABS, PVB and PVA can be used as mold materials. In particular, PVA is a promising material as it is soluble in water. The studied method simplifies the fabrication of soft devices, allowing the fabrication of overhangs and buried channels in a single casting step.

General information

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Organisations: BioMediTech, Research group: Bioinspired Materials and Robotics (BMR)
Contributors: Koivikko, A., Sariola, V.
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Source: Scopus
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Direct model predictive power control of a series-connected modular rectifier

This paper presents a direct model predictive power control for a series-connected modular rectifier. The topology combines a diode rectifier and an active-front-end (AFE) converter to achieve a medium voltage target. A voltage control loop regulates the total dc voltage, providing the power references to the inner direct model predictive control. Operation under the desired real and reactive power is achieved, while minimizing the converter switching frequency. Moreover, successful operation and control of the AFE converter is guaranteed thanks to a hard constraint included in the optimization problem.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Electrical Engineering, Politecnico di Milano, Technische Universitat Munchen
Contributors: Rossi, M., Liegmann, E., Karamanakos, P., Castelli-Dezza, F., Kennel, R.
Number of pages: 6
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http://urn.fi/URN:NBN:fi:tuni-201912116776
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Operating point dependent variable switching point predictive current control for PMSM drives

This contribution presents a direct model predictive current control approach that achieves favorable performance during transients while minimizing the torque and current ripples at steady-state operation by increasing the granularity at which switching can be performed. To meet the control goals, an optimization problem is solved in real-time that decides whether only one discrete voltage space vector or a combination of two is selected. In the latter case, a variable switching point, i.e., a time instant within the control interval at which the converter switches change state, is computed. The proposed method is advantageous, e.g., for electric drives in machine tools, in which, depending on the operating point, fast dynamics and a low torque ripple are important. The approach is evaluated at the example of a two-level voltage source inverter driving a permanent magnet synchronous machine.

General information

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MoE publication type: A4 Article in a conference publication
Organisations: Electrical Engineering, Institute ELSYS, Technische Universitat Munchen
Contributors: Wendel, S., Karamanakos, P., Dietz, A., Kennel, R.
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ASJC Scopus subject areas: Electrical and Electronic Engineering, Mechanical Engineering, Control and Optimization
Keywords: Direct model predictive control (DMPC), Finite control set model predictive control (FCS-MPC), SoC FPGA, Variable switching point predictive current control (VSP2CC)

Electronic versions:

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http://urn.fi/URN:NBN:fi:tuni-202001151296
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

On the complexity of restoring corrupted colorings

In the r-Fix problem, we are given a graph G, a (non-proper) vertex-coloring c: V(G) → [r] , and a positive integer k. The goal is to decide whether a proper r-coloring c is obtainable from c by recoloring at most k vertices of G. Recently, Junosza-Szaniawski et al. (in: SOFSEM 2015: theory and practice of computer science, Springer, Berlin, 2015) asked whether the problem has a polynomial kernel parameterized by the number of recolorings k. In a full version of the manuscript, the authors together with Garnero and Montealegre, answered the question in the negative: for every r≥ 3 , the problem r-Fix does not admit a polynomial kernel unless [InlineEquation not available: see fulltext.]. Independently of their work, we give an alternative proof of the theorem. Furthermore, we study the complexity of r-Swap, where the only difference from r-Fix is that instead of k recolorings we have a budget of k color swaps. We show that for every r≥ 3 , the problem r-Swap is [InlineEquation not available: see fulltext.]-hard whereas r-Fix is known to be FPT. Moreover, when r is part of the input, we observe both Fix and Swap are [InlineEquation not available: see fulltext.]-hard parameterized by the treewidth of the input graph. We also study promise variants of the problems, where we are guaranteed that a proper r-coloring c is indeed obtainable from c by some finite number of swaps. For instance, we prove that for r= 3 , the problems r-Fix-Promise and r-Swap-Promise are [InlineEquation not available: see fulltext.]-hard for planar graphs. As a consequence of our reduction, the problems cannot be solved in 2o(n) time unless the Exponential Time Hypothesis fails.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Bell Labs
Contributors: De Biasi, M., Lauri, J.
Number of pages: 20
Pages: 1150-1169
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Journal: Journal of Combinatorial Optimization
Volume: 37
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Original language: English
ASJC Scopus subject areas: Computer Science Applications, Discrete Mathematics and Combinatorics, Control and Optimization, Computational Theory and Mathematics, Applied Mathematics
Keywords: Combinatorial reconfiguration, Computational complexity, Graph coloring, Local search, Parameterized complexity
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Source: Scopus
Source ID: 85053264976
Research output: Contribution to journal › Article › Scientific › peer-review

Monitoring of production processes and the condition of the production equipment through the internet

The decreasing prices of monitoring equipment have vastly increased the opportunities to utilize local data, and data processing for wider global web-based monitoring purposes. The possible amount of data flowing though different levels can be huge. Now the question is how to handle this opportunity in both dynamic and secure way. The paper presents a new concept to manage data for monitoring through the Internet. The concept is based on the use of Arrowhead Framework (AF) and MIMOSA data model, and selected edge, and gateway devices together with cloud computing opportunities. The concept enables the flexible and secure orchestration of run-time data sources and the utilization of computational services for various process and condition monitoring needs.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication

Organisations: Computing Sciences, Research group: Automation and Systems Theory, VTT Technical Research Centre of Finland, AITIA International Inc., Budapest University of Technology and Economics, Konecranes, Metso Minerals, Wapice Ltd, CrossControl, Mondragon University
Contributors: Halme, J., Jantunen, E., Hastbacka, D., Hegedus, C., Varga, P., Bjorkbom, M., Mesia, H., More, R., Jaatinen, A., Barna, L., Tuominen, P., Pettinen, H., Elo, M., Larranaga, M.
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Pages: 1295-1300
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ASJC Scopus subject areas: Information Systems, Information Systems and Management, Control and Optimization, Decision Sciences (miscellaneous)
DOIs:

10.1109/CoDIT.2019.8820688

Bibliographical note
EXT="Barna, Laurentiu"
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Impedance-based interactions in grid-tied three-phase inverters in renewable energy applications
Impedance-ratio-based interaction analyses in terms of stability and performance of DC-DC converters is well established. Similar methods are applied to grid-connected three-phase converters as well, but the multivariable nature of the converters and the grid makes these analyses very complex. This paper surveys the state of the interaction analyses in the grid-connected three-phase converters, which are used in renewable-energy applications. The surveys show clearly that the impedance-ratio-based stability assessment are usually performed neglecting the cross-couplings between the impedance elements for reducing the complexity of the analyses. In addition, the interactions, which affect the transient performance, are not treated usually at all due to the missing of the corresponding analytic formulations. This paper introduces the missing formulations as well as explicitly showing that the cross-couplings of the impedance elements have to be taken into account for the stability assessment to be valid. In addition, this paper shows that the most accurate stability information can be obtained by means of the determinant related to the associated multivariable impedance ratio. The theoretical findings are also validated by extensive experimental measurements.

General information
Publication status: Published
MoE publication type: A2 Review article in a scientific journal
Organisations: Electrical Engineering, Research group: Power electronics, Research area: Power engineering, Automation Technology and Mechanical Engineering, Research group: Automation and Systems Theory, Aalto University
Contributors: Suntio, T., Messo, T., Berg, M., Alenius, H., Reinikka, T., Luhtala, R., Zenger, K.
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Article number: 464
ISSN (Print): 1996-1073
Ratings:

Scopus rating (2019): CiteScore 3.8 SJR 0.635 SNIP 1.154
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ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering
Keywords: Grid synchronization, Power electronics, Power grid, Source and load impedance, Stability, Transient dynamics
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Source: Scopus
Source ID: 85060952873
Research output: Contribution to journal › Review Article › Scientific › peer-review

Direct fixed-step maximum power point tracking algorithms with adaptive perturbation frequency

Owing to the good trade-off between implementation and performance, fixed-step direct maximum power point tracking techniques (e.g., perturb and observe and incremental conductance algorithms) have gained popularity over the years. In order to optimize their performance, perturbation frequency and perturbation step size are usually determined a priori. While the first mentioned design parameter is typically dictated by the worst-case settling time of the combined energy conversion system, the latter must be high enough to both differentiate the system response from that caused by irradiation variation and match the finite resolution of the analog-to-digital converter in case of digital implementation. Well-established design guidelines, however, aim to optimize steady-state algorithm performance while leaving transients nearly untreated. To improve transient behavior while keeping the steady-state operation unaltered, variable step direct maximum power point tracking algorithms based on adaptive perturbation step size were proposed. This paper proposes a concept of utilizing adaptive perturbation frequency rather than variable step size, based on recently revised guidelines for designing fixed-step direct maximum power point tracking techniques. Preliminary results demonstrate the superiority of the proposed method over adaptive perturbation step size operation during transients, without compromising the steady state performance.

General information

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Organisations: Electrical Engineering, Research group: Power electronics, Ben-Gurion University of the Negev
Contributors: Amer, E., Kuperman, A., Suntio, T.
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Journal: Energies
Volume: 12
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ISSN (Print): 1996-1073
Ratings:

Scopus rating (2019): CiteScore 3.8 SJR 0.635 SNIP 1.154
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ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering
Keywords: Maximum power point tracking, Perturbation frequency, Photovoltaic generators, Step size
Electronic versions:

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URLs:

http://urn.fi/URN:NBN:fi:tty-201905021455
Source: Scopus
Source ID: 85060911593
Research output: Contribution to journal › Article › Scientific › peer-review

Performance evaluation of bandwidth reservation for mmWave 5G NR systems

Introduction: In 3GPP New Radio (NR) systems, frequent radio propagation path blockages can lead to the disconnection of ongoing sessions already accepted into the system, reducing the quality of service in the network. Controlling access to system resource by prioritizing for the ongoing sessions can increase the session continuity. In this paper, we propose resource allocation with a reservation mechanism. Purpose: Development of a mathematical model for analyzing the effect of this mechanism on other system performance indicators - dropping probabilities for new and ongoing sessions and system utilization. The model takes into account the key features of the 3GPP NR technology, including the height of the interacting objects, the spatial distribution and mobility of the blockers, as well as the line-of-sight propagation properties between the transceivers for mmWave NR technology. Results: We analyzed the reservation mechanism with the help of a developed model in the form of a resource queueing system with signals, where the base station bandwidth corresponds to the resource, and the signals model a change in the line-of-sight conditions between the receiving and transmitting devices. Creating a priority for ongoing sessions whose service has not yet been completed provides a considerable flexibility for balancing the session continuity and dropping of a new session, with a slight decrease in the efficiency of the radio resource utility. With the developed model, we showed that reserving even a small bandwidth (less than 10% of the total resources) to maintain the ongoing sessions has a positive effect on their continuity, as it increases the probability of their successful completion. Practical relevance: The proposed mechanism works more efficiently in overload conditions and with sessions which have a high data transfer rate requirements. This increases the demand for the proposed mechanism in 5G NR communication systems.

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MoE publication type: A1 Journal article-refereed
Organisations: Electrical Engineering, Research group: Emerging Technologies for Nano-Bio-Info-Cogno, Peoples' Friendship University of Russia, Federal Research Center Computer Science and Control of the Russian Academy of Sciences
Contributors: Begishev, V. O., Sopin, E. S., Molchanov, D. A., Samouylov, A. K., Gaidamaka, Y. V., Samouylov, K. E.
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Issue number: 5
ISSN (Print): 1684-8853
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Scopus rating (2019): CiteScore 0.5 SJR 0.201 SNIP 0.507
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ASJC Scopus subject areas: Software, Control and Systems Engineering, Information Systems, Human-Computer Interaction, Computer Science Applications, Control and Optimization
Keywords: 5G networks, Bandwidth reservation, Millimeter wave, New Radio, New session drop probability, Ongoing session drop probability, Session continuity, System resource utilization
DOIs:

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Source: Scopus
Source ID: 85082424315
Research output: Contribution to journal › Article › Scientific › peer-review

A Real-Time Big Data Control-Theoretical Framework for Cyber-Physical-Human Systems
Cyber-physical-human systems naturally arise from interdependent infrastructure systems and smart connected communities. Such applications require ubiquitous information sensing and processing, intelligent machine-to-machine communication for a seamless coordination, as well as intelligent interactions between humans and machines. This chapter presents a control-theoretical framework to model heterogeneous physical dynamic systems, information and communication, as well as cooperative controls and/or distributed optimization of such interconnected systems. It is shown that efficient analytical and computational algorithms can be modularly designed and hierarchically implemented to operate and optimize cyber-physical-human systems, first to quantify individually the input–output relationship of nonlinear dynamic behaviors of every physical subsystem, then to coordinate locally both cyber-physical interactions of neighboring agents as well as physical-human interactions, and finally to dynamically model and optimize the overall networked system. The hierarchical structure makes the overall optimization and control problem scalable and solvable. Moreover, the three levels integrate individual designs and optimization, distributed cooperative optimization, and decision-making through real-time, data-driven, model-based learning and control. Specifically, one of the contributions of the chapter is to demonstrate how the combination of dissipativity theory and cooperative control serves as a natural framework and promising tools to analyze, optimize, and control such large-scale system. Application to digital power grid is investigated as an illustrative example.

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MoE publication type: A3 Part of a book or another research book
Organisations: Automation Technology and Mechanical Engineering, University of Central Florida
Contributors: Gusrialdi, A., Xu, Y., Qu, Z., Simaan, M. A.
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ASJC Scopus subject areas: Control and Optimization
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10.1007/978-3-030-25446-9_7
Source: Scopus
Source ID: 85073243534
Research output: Chapter in Book/Report/Conference proceeding › Chapter › Scientific › peer-review

Customized dimensional analysis conceptual modelling framework for design optimization—a case study on the cross-flow micro turbine model

Dimensional Analysis Conceptual Modelling (DACM) is a framework used for conceptual modelling and simulation in system and product designs. The framework is based on cause–effect analysis between variables and functions in a problem. This article presents an approach that mobilizes concepts from the DACM framework to assist solve high-dimensional expensive optimization problems with lower computational costs. The latter fundamentally utilizes theories and concepts from well-practised dimensional analysis, functional modelling and bond graphing. Statistical design-of-experiments theory is also utilized in the framework to measure impact levels of variables towards the objective. Simplifying as well as decomposing followed by optimization of expensive problems are the focuses of the article. To illustrate the approach, a case study on the performance optimization of a cross-flow micro hydro turbine is presented. The customized DACM framework assisted optimization approach converges faster and returns better results than the one without. A single-step simplification approach is employed in the case study and it returns a better average optimization result with about only one fifth of the function evaluations compared to optimization using the original model.

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MoE publication type: A1 Journal article-refereed
Organisations: Mechanical Engineering and Industrial Systems, Research area: Manufacturing and Automation, University of Stavanger, Simon Fraser University
Contributors: Woldemariam, E. T., Coatanéa, E., Wang, G. G., Lemu, H. G., Wu, D.
Pages: 1168-1184
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ISSN (Print): 0305-215X
Ratings:
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Original language: English
ASJC Scopus subject areas: Computer Science Applications, Management Science and Operations Research, Control and Optimization, Industrial and Manufacturing Engineering, Applied Mathematics
Keywords: Causality analysis, conceptual modelling, DACM assisted optimization, high-dimensional optimization, micro cross-flow turbine
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10.1080/0305215X.2018.1519556
Source: Scopus
Source ID: 85054818014
Research output: Contribution to journal › Article › Scientific › peer-review

Design and Control of a Flexible Joint as a Hydraulic Series Elastic Actuator for Manipulation Applications

Lightweight arms with electrical servomotor drives have demonstrated outstanding performance and speed in exoskeletons, prosthesis, and legged robot applications. They all share a similarity in actuation, which is based on series elastic actuators (SEAs). In SEAs, the system benefits from known compliance in the actuation that improves the overall performance, especially in contact with an environment that can have an unknown stiffness in assembly tasks. In some of these cases, harmonic drives or gears on the power transmission lines create the robot's compliance. For hydraulically actuated SEAs, Pratt and Krupp addressed the SEA challenges for lightweight hydraulic manipulators. However, this paper focuses on the design and control architecture of SEAs in heavy-duty manipulation having hydraulic load dynamics with variable stiffness or damping of fluid flexibility. This system faces challenging issues of payload dynamics and compressibility of fluid with high order system. A hydraulic SEA concept is designed, and a fifth-order state space SEA model is feedback controlled in a free space motion to demonstrate load dynamics of hydraulic actuation. In addition, a P controller and a controller based on integral of time-weighted absolute error (ITAE) are designed. The simulation results show the latter has better performance in the spring deflection of the SEA. A mixed working condition that changes from a purely inertia payload to an inertia and elastic reaction force is designed to examine the switching smoothness for varying

payloads, and the control adaptability of controllers in different working conditions.

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Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation Technology and Mechanical Engineering, Research group: Innovative Hydraulic Automation, Chang'an University, Tampere University
Contributors: Cao, X., Aref, M. M., Mattila, J.
Number of pages: 6
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Keywords: Elastic Actuator, Heavy Duty Manipulation
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INT=atme,"Cao, Xuepeng"
Source: Scopus
Source ID: 85085856758
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Identification of three-phase grid impedance in the presence of parallel converters
Grid impedance is an important parameter which affects the control performance of grid-connected power converters. Several methods already exist for optimizing the converter control system based on knowledge of grid impedance value. Grid impedance may change rapidly due to fault or disconnection of a transmission line. Therefore, online grid identification methods have been recently proposed to have up-to-date information about the grid impedance value. This is usually done by perturbing the converter output current and measuring the response in output voltage. However, any parallel converters connected to the same interface point will cause errors, since the measured current differs from the current that is flowing through the grid interface point. This paper points out challenges and errors in grid impedance identification, caused by parallel converters and their internal control functions, such as grid-voltage support. Experimental grid-impedance measurements are shown from the power hardware-in-the-loop setup developed at DNV-GL Flexible Power Grid Lab.

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MoE publication type: A1 Journal article-refereed
Organisations: Automation Technology and Mechanical Engineering, Research group: Automation and Systems Theory, Research group: Power electronics, Electrical Engineering, Eindhoven University of Technology, DNV-GL
Contributors: Luhtala, R., Messo, T., Roinila, T., Alenius, H., Jong, E. D., Burstein, A., Fabian, A.
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ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering

Keywords: DC–AC power converters, Grid impedance identification, Power hardware-in-the-loop
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Source: Scopus
Source ID: 85068784950
Research output: Contribution to journal › Article › Scientific › peer-review

M-Estimator Application in Real-Time Sensor Fusion for Smooth Position Feedback of Heavy-Duty Field Robots

In this paper, we study the performance of a complementary filter with adaptive weights in a sensor fusion application for real-time localization of an omnidirectional field robot. The test-case robot is a large, four-wheel drive and steer (4WDS) construction vehicle with nonlinear internal dynamics and hydraulic driving and steering actuators. Our objective is to provide the vehicle's real-time controller with robust, smooth feedback that prevents unnecessary oscillations in steering, which can waste significant amounts of energy. We do so by assigning weights for measurements based on their consistency with the robot's motions. The calculations are based on two main data sources: (1) measured velocity vectors from wheel driving (odometer) and steering of the 4WDS test-case robot; and (2) data obtained from a differential global navigation satellite system on the absolute pose of the robot. We show that the sensor fusion is robust to the noise and single point failures of the sensors, while the maximum heading oscillations are reduced by 70%-95%, preserving the accuracy of the global positioning system. Moreover, we demonstrate the feasibility and efficacy of the real-time implementation of this filtering method in path-following control of the robot.

General information

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Organisations: Automation Technology and Mechanical Engineering, Research group: Innovative Hydraulic Automation
Contributors: Liikanen, H., Aref, M. M., Mattila, J.
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Pages: 368-373
Publication date: 2019

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ISBN (Print): 978-1-7281-3459-8
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ASJC Scopus subject areas: Artificial Intelligence, Mechanical Engineering, Control and Optimization
Keywords: GNSS, GPS, heavy-dutyfield robot, motion estimation, path following, sensor fusion, wheel odometry
DOIs:

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Source ID: 85085865017
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Power electronics in renewable energy systems

General information

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Organisations: Electrical Engineering, Research group: Power electronics, Research area: Power engineering
Contributors: Suntio, T., Messo, T.
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ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering
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Source ID: 85066827333
Research output: Contribution to journal › Editorial › Scientific

Kalman-Type Filters and Smoothers for Pedestrian Dead Reckoning

In this paper, we present a method for device localization based on the fusion of location data from Global Navigation Satellite System and data from inertial sensors. We use a Kalman filter as well as its non-linear variants for realtime position estimation, and corresponding smoothers for offline position estimation. In all filters we use information about changes of user's heading, which are computed from the acceleration and gyroscope data. Models used with Extended and Unscented Kalman filters also take into account information about step length, whereas Kalman Filter does not, because the measurement is non-linear. In order to overcome this shortcoming, we introduce a modified Kalman Filter which adjusts the state vector according to the step length measurements. Our experiments show that use of step length information does not significantly improve performance when location measurements are constantly available. However, in real situations, when location data is partially unavailable, information about step length and its appropriate integration into the filter design is important, and improve localization accuracy considerably.

General information

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Organisations: Automation and Hydraulic Engineering, HERE Technologies, Deprtment of Electrical Engineering and Automation, Aalto University
Contributors: Ivanov, P., Raitoharju, M., Piché, R.
Number of pages: 7
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ASJC Scopus subject areas: Artificial Intelligence, Computer Science Applications, Control and Optimization
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Bibliographical note

jufoid=72210
Source: Scopus
Source ID: 85059102314
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Constrained Long-Horizon Direct Model Predictive Control for Synchronous Reluctance Motor Drives

A finite control set model predictive control strategy for the control of the stator currents of a synchronous reluctance motor driven by a three-level neutral point clamped inverter is presented in this paper. The presented algorithm minimizes the stator current distortions while operating the drive system at switching frequencies of a few hundred Hertz. Moreover, the power electronic converter is protected by overcurrents and/or overvoltages owing to a hard constraint imposed on the stator currents. To efficiently solve the underlying integer nonlinear optimization problem a sphere decoding algorithm

serves as optimizer. To this end, a numerical calculation of the unconstrained solution of the optimization problem is proposed, along with modifications in the algorithm proposed in [1] so as to meet the above-mentioned control objectives. Simulation results show the effectiveness of the proposed control algorithm.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Electrical Energy Engineering, Research group: Power electronics, Universita degli Studi di Padova, Italy, Technische Universitat Munchen
Contributors: Ortombina, L., Liegmann, E., Karamanakos, P., Tinazzi, F., Zigliotto, M., Kennel, R.
Number of pages: 8
Publication date: 10 Sep 2018

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ISBN (Print): 9781538655412
ASJC Scopus subject areas: Modelling and Simulation, Energy Engineering and Power Technology, Electrical and Electronic Engineering, Control and Optimization
DOIs:

10.1109/COMPEL.2018.8460173

Bibliographical note
JUFOID=79370
Source: Scopus
Source ID: 85054503298
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Inertial Sensor-Based State Estimation of Flexible Links Subject to Bending and Torsion
In this study, we propose an observer design based on inertial sensors and the finite element (FE) method to estimate the flexural states of a long-reach and highly flexible manipulator in a 3D plane of motion. Vertical and lateral dynamic bendings are considered, along with deformation due to torsion. The aim is to achieve accurate end-point positioning by using the estimated flexural degrees-of-freedom, which are formulated using an FE model. The states are reconstructed based on angular velocity measurements, which are obtained from strap-on inertial sensors placed along the flexible link. For validation, a motion-capture setup consisting of three OptiTrack cameras is used. The experiments are conducted on a hydraulic manipulator that has a single 4.5-m long flexible link with a tip mass. The validation is carried out by comparing the estimates to the OptiTrack reference measurements. The results demonstrate that this method provides satisfactory end-point positioning, while also being convenient for use in heavy-duty mobile manipulators.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation and Hydraulic Engineering, Research group: Innovative Hydraulic Automation
Contributors: Mäkinen, P., Mononen, T., Mattila, J.
Number of pages: 8
Publication date: 27 Aug 2018

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ASJC Scopus subject areas: Control and Optimization, Computer Science Applications, Electrical and Electronic Engineering, Mechanical Engineering, Instrumentation
Keywords: finite element method, inertial sensors, state estimation
Electronic versions:

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DOIs:

10.1109/MESA.2018.8449188
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http://urn.fi/URN:NBN:fi:tuni-202001271550
Source: Scopus
Source ID: 85053925148

Real-time and Robust Collaborative Robot Motion Control with Microsoft Kinect ® v2

Recent development in depth sensing provide various opportunities for the development of new methods for Human Robot Interaction (HRI). Collaborative robots (co-bots) are redefining HRI across the manufacturing industry. However, little work has been done yet in the field of HRI with Kinect sensor in this industry. In this paper, we will present a HRI study using nearest-point approach with Microsoft Kinect v2 sensor's depth image (RGB-D). The approach is based on the Euclidean distance which has robust properties against different environments. The study aims to improve the motion performance of Universal Robot-5 (UR5) and interaction efficiency during the possible collaboration using the Robot Operating System (ROS) framework and its tools. After the depth data from the Kinect sensor has been processed, the nearest points differences are transmitted to the robot via ROS.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Mechanical Engineering and Industrial Systems, Research area: Manufacturing and Automation, Signal Processing, Research group: Vision
Contributors: Teke, B., Lanz, M., Kämäräinen, J., Hietanen, A.
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Article number: 8449156
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Keywords: collaborative robots, human-robot collaboration, Human-robot interaction, Microsoft Kinect v2, ROS, trajectory planning
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Bibliographical note

INT=mei,"Teke, Burak"
Source: Scopus
Source ID: 85053893135
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Role-based visualization of industrial IoT-based systems

The competition among manufacturers in the global markets calls for the enhancement of the agility and performance of the production process and the quality of products. As a result, the production systems should be designed in such a way to provide decision makers with visibility and analytics. To fulfill these objectives, the development of information systems in manufacturing industries has intensified in the past few years. On the other hand, the volume of data which is being generated on the shop floor is rising. To improve the efficiency of manufacturing processes, this amount of data should be analyzed by decision makers. To cope with this challenge, advanced visualization is needed to assist users to gain insight into data and make effective decisions faster. This paper describes an approach for building a role-based visualization of industrial IoT. We propose an extendible architecture that anticipates the future growth of data. By using the IoT platform introduced in this paper, selected Key Performance Indicators(KPI) can be monitored by different levels of enterprise. The prototype IoT dashboard has been implemented for a pilot production line 'Festo didactic training line' located in Seinäjoki University of Applied Sciences(SeAMK) and results have been validated.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Mechanical Engineering and Industrial Systems, Research area: Manufacturing and Automation, Seinäjoki University of Applied Sciences
Contributors: Mahmoodpour, M., Lobov, A., Lanz, M., Mäkelä, P., Rundas, N.
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Publisher: IEEE
Article number: 8449183
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ASJC Scopus subject areas: Control and Optimization, Computer Science Applications, Electrical and Electronic Engineering, Mechanical Engineering, Instrumentation
Keywords: Data Collection, Information Visualization, Internet of Things (IoT)
DOIs:
10.1109/MESA.2018.8449183
Source: Scopus
Source ID: 85053938410
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Complete Odometry Estimation of a Vehicle Using Single Automotive Radar and a Gyroscope
In this paper, we propose an algorithm for complete odometry of a vehicle on a horizontal plane., that is., estimation of linear velocity vector (forward and sideslip speeds) and angular speed of a vehicle. The vehicle is equipped with an automotive Radar sensor and a vertical gyro. The Radar sensor provides radial speed and azimuth angle of number of objects in the environment. We first derive the kinematic constraints imposed on the vehicle motion and stationary points in the environment. Using the constraints we classify the points detected by the Radar to stationary and non-stationary points. It is known that using data from a single Radar., the abovementioned constraints are singular. Previous works have thus proposed the use of more than one Radar sensor., or they have neglected the sideslip speed. In our work, we then use the Radar data of the stationary objects and a gyro data to solve an optimization algorithm to calculate vehicle odometry. Experimentation has been performed with a non-road vehicle driven on a straight path and on a circular path. We report our findings and show efficacy of the algorithm in comparison to the state of art [8] as well as wheel odometry and a complete navigation solution (including GNSS) as the reference path.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation and Hydraulic Engineering
Contributors: Ghabcheloo, R., Siddiqui, S.
Number of pages: 6
Pages: 855-860
Publication date: 20 Aug 2018

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Article number: 8442474
ISBN (Print): 9781538678909
ASJC Scopus subject areas: Artificial Intelligence, Control and Systems Engineering, Mechanical Engineering, Control and Optimization
DOIs:
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Bibliographical note
INT=aut,"Siddiqui, Shadman"
Source: Scopus
Source ID: 85053455838
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Improvement of GPS and BeiDou extended orbit predictions with CNNs
This paper presents a method for improving the accuracy of extended GNSS satellite orbit predictions with convolutional neural networks (CNN). Satellite orbit predictions are used in self-assisted GNSS to reduce the Time to First Fix of a satellite positioning device. We describe the models we use to predict the satellite orbit and present the improvement method that uses CNN. The CNN estimates future prediction errors of our model and these estimates are used to correct our orbit predictions. We also describe how the neural network can be implemented into our prediction algorithm. In tests with GPS and BeiDou data, the method significantly improves orbit prediction accuracy. For example, the 68% error quantile of 7 day orbit prediction errors of GPS satellites was reduced by 45% on average.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation and Hydraulic Engineering, Research group: Automation and Systems Theory, Mathematics, Research group: Positioning
Contributors: Pihlajasalo, J., Leppäkoski, H., Ali-Löytty, S., Piché, R.
Number of pages: 6
Pages: 54-59
Publication date: 10 Aug 2018

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ISBN (Print): 9781538649626
ASJC Scopus subject areas: Computer Networks and Communications, Signal Processing, Control and Optimization
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Bibliographical note
INT=mat,"Jaakko Pihlajasalo"
Source: Scopus
Source ID: 85052494723
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Improved modelling of electric loads for enabling demand response by applying physical and data-driven models: Project Response

Accurate load and response forecasts are a critical enabler for high demand response penetrations and optimization of responses and market actions. Project RESPONSE studies and develops methods to improve the forecasts. Its objectives are to improve 1) load and response forecast and optimization models based on both data-driven and physical modelling, and their hybrid models, 2) utilization of various data sources such as smart metering data, weather data, measurements from substations etc., and 3) performance criteria of load forecasting. The project applies, develops, compares, and integrates various modelling approaches including partly physical models, machine learning, modern load profiling, autoregressive models, and Kalman-filtering. It also applies non-linear constrained optimization to load responses. This paper gives an overview of the project and the results achieved so far.

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Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Electrical Energy Engineering, Research group: Power systems, Research area: Information Systems in Automation, Automation and Hydraulic Engineering, VTT Technical Research Centre of Finland, University of Eastern Finland
Contributors: Koponen, P., Hanninen, S., Mutanen, A., Koskela, J., Rautiainen, A., Järventausta, P., Niska, H., Kolehmainen, M., Koivisto, H.
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ASJC Scopus subject areas: Artificial Intelligence, Energy Engineering and Power Technology, Control and Optimization
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http://urn.fi/URN:NBN:fi:tty-201808172164
Source: Scopus

Source ID: 85050244199
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

An approach for implementing key performance indicators of a discrete manufacturing simulator based on the ISO 22400 standard

Performance measurement tools and techniques have become very significant in today's industries for increasing the efficiency of their processes in order to face the competitive market. The first step towards performance measurement is the real-time monitoring and gathering of the data from the manufacturing system. Applying these performance measurement techniques on real-world industry in a way that is more general and efficient is the next challenge. This paper presents a methodology for implementing the key performance indicators defined in the ISO 22400 standard-Automation systems and integration, Key performance indicators (KPIs) for manufacturing operations management. The proposed methodology is implemented on a multi robot line simulator for measuring its performance at runtime. The approach implements a knowledge-based system within an ontology model which describes the environment, the system and the KPIs. In fact, the KPIs semantic descriptions are based on the data models presented in the Key Performance Indicators Markup Language (KPIML), which is an XML implementation of models developed by the Manufacturing Enterprise Solutions Association (MESA) international organization.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation and Hydraulic Engineering, Research group: Automation and Systems Theory
Contributors: Muhammad, U., Ferrer, B. R., Mohammed, W. M., Lastra, J. L.
Number of pages: 8
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Publisher: IEEE
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ASJC Scopus subject areas: Artificial Intelligence, Hardware and Architecture, Control and Optimization, Industrial and Manufacturing Engineering
Keywords: ISO 22400 standard, Key performance indicators, Knowledge-based system, Manufacturing systems, Ontology
DOIs:
10.1109/ICPHYS.2018.8390779

Bibliographical note

EXT="Muhammad, Usman"
Source: Scopus
Source ID: 85050127723
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Towards the deployment of cloud robotics at factory shop floors: A prototype for smart material handling

The evolution of industries and their needs towards the implementation of Industry 4.0 based systems has brought both new technological challenges and opportunities. This article proposes the adoption and deployment of cloud robotics at factories to enhance the control and monitoring of processes, such as handling materials multiple assemblies in single cells. The ultimate research objective of this research is the offloading computation and integrating cloud robotics into an industrial scenario. However, the investigation of state of the art techniques, tools and technologies, and the development of functional prototypes is beforehand required. Then, this article presents a small-scale system as a prototype that employs the Google cloud vision API as a resource that, in turn, is used by networked agents for supporting the decision-making in the process of handling material commodities at factory shop floor. The overall concept as well as the interaction between the main actors of the prototype is detailed. Finally, further research directions are discussed.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Automation and Hydraulic Engineering, Research group: Automation and Systems Theory
Contributors: Hussnain, A., Ferrer, B. R., Lastra, J. L.
Number of pages: 7
Pages: 44-50
Publication date: 15 Jun 2018

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Publisher: IEEE

ISBN (Electronic): 9781538665312
ASJC Scopus subject areas: Artificial Intelligence, Hardware and Architecture, Control and Optimization, Industrial and Manufacturing Engineering
Keywords: Cloud Robotics, Industrial Cyber-Physical Systems, Industry 4.0, Multi-Agent Systems, SOA
DOIs:
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Bibliographical note
INT=aut,"Hussnain, Ali"
Source: Scopus
Source ID: 85050146182
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Sustainable electric vehicle - Prosumer framework and policy mix
Electric vehicles have pro-environmental advantages compared to traditional automobiles, or even hybrids: they can help reducing pollution and noise levels locally, and greenhouse gas emissions globally. However, there are still many challenges that the electric vehicles must overcome before reaching level of diffusion that can have significant impact on sustainability. This paper evaluates combined sustainability of electric vehicle and small-scale energy production. We propose a framework for sustainable electric vehicle - energy prosumer integration and outline a policy mix that is needed to support adoption of both renewable energy technologies and electric vehicles.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Industrial and Information Management, School of Management Politics
Contributors: Kotilainen, K., Mäkinen, S. J., Valta, J.
Number of pages: 6
Pages: 1-6
Publication date: 8 Jun 2018

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Title of host publication: 2017 IEEE Innovative Smart Grid Technologies - Asia : Smart Grid for Smart Community, ISGT-Asia 2017
Publisher: IEEE
ISBN (Electronic): 9781538649503
ASJC Scopus subject areas: Artificial Intelligence, Computer Networks and Communications, Energy Engineering and Power Technology, Electrical and Electronic Engineering, Control and Optimization, Safety, Risk, Reliability and Quality
Keywords: Electric vehicle, Policy, Prosumer, Renewable energy, Sustainable
DOIs:
10.1109/ISGT-Asia.2017.8378406

Bibliographical note
EXT="Kotilainen, Kirsi"
Source: Scopus
Source ID: 85050005345
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Dual-frequency signal processing architecture for robust and precise positioning applications
Availability of new GPS civil signals L2C and L5 along with existed L1C/A signal and Galileo E1/E5/E6 signals has increased the potential ways to generate linear combination of signals to remove ionosphere errors and improve accuracy in carrier integer ambiguity resolution. Conventionally, a linear combination of dual frequency signals has been used to remove first order ionosphere delays incurred in signal propagation path which is a major source of range error. Out of the three civil signals in GPS and Galileo system, L5/E5 signals have advanced signal features such as higher received power, faster chip rate and lower carrier frequency than L1/E1 and L2C/E6 signals. Hence, dual frequency receiver with combination of L1/L5 and E1/E5 signals is more suitable to remove ionosphere delay and get benefit from L5/E5 signal characteristics. However, the major limitation of linear combination of signal observations is an amplification of receiver noise. To get benefit of two frequency signals, a suitable signal processing architecture is needed. By taking advantage of GPS L5/Galileo E5 signal characteristics, a dual frequency signal processing architecture is proposed with an aim to reduce the ionosphere-free signal observation noise and to enhance the L1/E1 signal tracking loop sensitivity. The L1/E1 signal tracking loop sensitivity can be enhanced by Doppler aiding from L5/E5 signal tracking loop. The low noise L5/E5 signal Doppler aid reduces the noise in the L1/E1 signal tracking loop. Moreover, two frequency signals tracked with common Doppler estimate will have common observation errors, which will get cancel in linear combination of observations i.e. ionosphere-free, wide-lane etc. Further, code phase observations can be smoothed (Hatch filter) using carrier phase observations. The carrier phase observations are limited by cycle slip. Hence, we have investigated an optimum combination of divergence-free and ionosphere-free pseudorange smoothing using dual-frequency carrier

Doppler observations for GPS L1/L5 and Galileo E1/E5 signals. The cycle slip in carrier phase observations can be neglected in carrier Doppler observations. The proposed signal processing architecture incorporated in GPS L1/L5 and Galileo E1/E5 dual frequency receiver will ensure robust signal tracking and minimum pseudorange errors, suitable to a range of high accuracy standalone and code differential positioning applications. The performance of the proposed dual frequency signal processing architecture is evaluated with GPS L1/L5 signals collected from Block-IIF satellites.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Electronics and Communications Engineering, Faculty of Electronics and Instrument Engineering, Samara National Research University
Contributors: Bolla, P., Lohan, E.
Number of pages: 9
Pages: 72-80
Publication date: 5 Jun 2018

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Publisher: IEEE
ISBN (Electronic): 9781538616475
ASJC Scopus subject areas: Automotive Engineering, Aerospace Engineering, Control and Optimization
Keywords: Carrier Doppler smoothing, Doppler aiding, Dual-frequency, Hatch filter
DOIs:

10.1109/PLANS.2018.8373367

Bibliographical note
EXT="Bolla, Padma"
jufoid=72638
Source: Scopus
Source ID: 85048871323
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Stabilization to trajectories for parabolic equations
Both internal and boundary feedback exponential stabilization to trajectories for semilinear parabolic equations in a given bounded domain are addressed. The values of the controls are linear combinations of a finite number of actuators which are supported in a small region. A condition on the family of actuators is given which guarantees the local stabilizability of the control system. It is shown that a linearization-based Riccati feedback stabilizing controller can be constructed. The results of numerical simulations are presented and discussed.

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MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Johann Radon Institute for Computational and Applied Mathematics
Contributors: Phan, D., Rodrigues, S. S.
Publication date: 1 Jun 2018
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Article number: 11
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Original language: English
ASJC Scopus subject areas: Control and Systems Engineering, Signal Processing, Control and Optimization, Applied Mathematics
Keywords: Feedback stabilization to trajectories, Semilinear parabolic equations
DOIs:

10.1007/s00498-018-0218-0
Source: Scopus
Source ID: 85050079985
Research output: Contribution to journal › Article › Scientific › peer-review

Analysis of differentially modulated cooperative communications over asymmetric fading channels

Differential modulation has largely re-attracted the attention of academia and industry due to its advantages relating to simple implementation and no need for knowledge of channel state information. The present work analyzes the average bit error rate performance of dual-hop cooperative systems over generalized multipath fading conditions. The considered system is differentially modulated and is assumed to operate based on the amplify-and-forward relaying protocol. Therefore, the main advantage of the considered set up is that it does not require any channel state information neither at the relay nor at the destination nodes. Novel closed-form expressions are derived for the end-to-end error rate under asymmetric generalized multipath fading conditions, which are encountered in realistic wireless communication scenarios. These expressions are subsequently employed in quantifying the effect of generalized fading conditions on the achieved bit error rate performance. It is shown that the impact of multipath fading and shadowing effects is detrimental at both high and low signal-to-noise ratio regimes as the corresponding deviations are often close to an order of magnitude. The incurred difference is also significantly different than the conventional Rayleigh fading conditions, which verifies that accurate channel characterization is of paramount importance in the effective design of conventional and emerging wireless technologies. In addition, it indicates that differential modulation can be a suitable modulation scheme for relay systems, under certain conditions, since it can provide adequate performance at a reduced implementation complexity.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Research group: Wireless Communications and Positioning, Electronics and Communications Engineering , Mohammed Bin Rashid Space Centre (MBRSC), Department of Electrical and Computer Engineering, Khalifa University , Aristotle University of Thessaloniki
Contributors: Almaeeni, S., Sofotasios, P. C., Muhaidat, S., Karagiannidis, G. K.
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Publication date: 16 May 2018

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ASJC Scopus subject areas: Computer Networks and Communications, Hardware and Architecture, Control and Optimization
DOIs:
10.1109/COMMNET.2018.8360284
Source: Scopus
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Capacity analysis under generalized composite fading conditions

Novel composite fading models were recently proposed based on inverse gamma distributed shadowing conditions. These models were extensively shown to provide remarkable modeling of the simultaneous occurrence of multipath fading and shadowing phenomena in emerging wireless scenarios such as cellular, off-body and vehicle-to-vehicle communications. Furthermore, the algebraic representation of these models is rather tractable, which renders them convenient to handle both analytically and numerically. The present contribution presents the major theoretical and practical characteristics of the η - μ / inverse gamma composite fading model, followed by a thorough ergodic capacity analysis. To this end, novel analytic expressions are derived, which are subsequently used in the evaluation of the corresponding system performance. In this context, the offered results are compared with respective results from cases assuming conventional fading conditions, which leads to the development of numerous insights on the effect of the multipath fading and shadowing severity on the achieved capacity levels. It is expected that these results will be useful in the design of timely and highly demanding wireless technologies, such as wearable, cellular and inter-vehicular communications as well in wireless power transfer based applications in the context of the Internet of Things.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Research group: Wireless Communications and Positioning, Electronics and Communications Engineering , Department of Electrical and Computer Engineering, Khalifa University, Queen's University, Belfast, Northern Ireland, Aristotle University of Thessaloniki
Contributors: Sofotasios, P. C., Yoo, S. K., Bhargav, N., Muhaidat, S., Cotton, S. L., Matthaiou, M., Valkama, M., Karagiannidis, G. K.
Number of pages: 10
Pages: 1-10

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ASJC Scopus subject areas: Computer Networks and Communications, Hardware and Architecture, Control and Optimization
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10.1109/COMMNET.2018.8360282
Source: Scopus
Source ID: 85048321386
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Maximum achievable throughput and interference mitigation for SUN in coexistence with WLAN
An optimum packet length selection scheme to maximize the throughput of a smart utility network (SUN) is introduced under wireless local area network (WLAN) interference system. The traditional and the investigated segmented packet collision models (PCM) are compared in terms of packet error rate (PER) and maximum achievable throughput. Furthermore, we quantify the impact of minimum mean square error (MMSE) interference mitigation for the SUN in the coexistence of WLAN interfering packets over multipath Rayleigh fading channel. The effect of the distance between the WLAN transmitter and the SUN receiver on the probability of error is also investigated.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Signal Processing, Qatar University, Electrical Engineering Department, University of Texas at Dallas
Contributors: Mohamed, S., Hamila, R., Al-Dhahir, N., Gouissem, A., Benbrahim, L., Gabbouj, M.
Number of pages: 6
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Keywords: Interference mitigation, Minimum mean square error, Packet collision model, Packet length, Smart grid, Smart utility network, Throughput
DOIs:

10.1109/COMMNET.2018.8360252

Bibliographical note
EXT="Hamila, Ridha"
Source: Scopus
Source ID: 85048343760
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Outage probability of multi-carrier NOMA systems under joint I/Q imbalance
Non-orthogonal multiple access (NOMA) has been recently proposed as a viable technology that can potentially improve the spectral efficiency of fifth generation (5G) wireless networks and beyond. However, in practical communication scenarios, transceiver architectures inevitably suffer from radio-frequency (RF) front-end related impairments that can lead to degradation of the overall system performance, with in-phase/quadrature-phase imbalance (IQI) constituting a major impairment in direct-conversion transceivers. In the present work, we quantify the effects of joint transmitter/receiver IQI on the performance of NOMA based multi-carrier (MC) systems under multipath fading conditions. Furthermore, we derive the asymptotic diversity order of the considered MC NOMA set up. Capitalizing on these results, we demonstrate that the effects of IQI differ considerably among NOMA users and depend on the underlying system parameters. For example, it is shown that the first sorted user appears more robust to IQI, which indicates that higher order users are more sensitive to the considered non-negligible impairment.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication

Organisations: Research group: Wireless Communications and Positioning, Electronics and Communications Engineering , Khalifa University, Department of Electrical and Computer Engineering, Aristotle University of Thessaloniki, University of Texas at Dallas
Contributors: Selim, B., Muhaidat, S., Sofotasios, P. C., Sharif, B. S., Stouraitis, T., Karagiannidis, G. K., Al-Dhahir, N.
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Source: Scopus
Source ID: 85048327091
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Online learning in neural decoding using incremental linear discriminant analysis
Neural decoding focuses on predicting behavior variables based on neural activities. Linear discriminant analysis (LDA) has been successfully used in pattern recognition and machine learning to find the set of discriminant vectors to characterize two or more classes of objects. However, LDA cannot be directly used for real-time neural decoding problems. In this paper, we propose an incremental LDA with online learning method to overcome this limitation. The dataflow techniques are implemented in the LIDE (LIghtweight Dataflow Environment), which provides capabilities to systematically optimize and integrate embedded software components for signal and information processing. Using these techniques along with online learning, an efficient real-time neural decoding system can be attained.

General information
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MoE publication type: A4 Article in a conference publication
Organisations: Pervasive Computing, University of Maryland, National Institute on Drug Abuse, University of Maryland, Baltimore, Department of Electrical and Computer Engineering
Contributors: Lee, Y., Madayambath, S. C., Liu, Y., Lin, D. T., Chen, R., Bhattacharyya, S. S.
Number of pages: 5
Pages: 173-177
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Publisher: IEEE
ISBN (Electronic): 9781538631942
ASJC Scopus subject areas: Control and Optimization, Artificial Intelligence
Keywords: dataflow, ILDA, incremental learning, Neural decoding, online learning
DOIs:

10.1109/CBS.2017.8266092
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Dynamic modeling and analysis of PCM-controlled DCM-operating buck converters-A reexamination
Peak-current-mode (PCM) control was proposed in 1978. The observed peculiar behavior caused by the application of PCM-control in the behavior of a switched-mode converter, which operates in continuous conduction mode (CCM), has led to a multitude of attempts to capture the dynamics associated to it. Only a few similar models have been published for a PCM-controlled converter, which operates in discontinuous conduction mode (DCM). PCM modeling is actually an extension of the modeling of direct-duty-ratio (DDR) or voltage-mode (VM) control, where the perturbed duty ratio is replaced by proper duty-ratio constraints. The modeling technique, which produces accurate PCM models in DCM, is developed in early 2000s. The given small-signal models are, however, load-resistor affected, which hides the real dynamic behavior of the associated converter. The objectives of this paper are as follows: (i) proving the accuracy of the modeling method published in 2001, (ii) performing a comprehensive dynamic analysis in order to reveal the real dynamics of the buck converter under PCM control in DCM, (iii) providing a method to improve the high-frequency accuracy of the small-signal models, and (iv) developing control-engineering-type block diagrams to facilitate the development of generalized transfer functions, which are applicable for PCM-controlled DCM-operated buck, boost, and buck-boost converters.

General information
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MoE publication type: A2 Review article in a scientific journal
Organisations: Electrical Energy Engineering, Research group: Power electronics, Research area: Power engineering
Contributors: Suntio, T.
Number of pages: 18
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Scopus rating (2018): CiteScore 3.3 SJR 0.612 SNIP 1.186
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ASJC Scopus subject areas: Renewable Energy, Sustainability and the Environment, Energy Engineering and Power Technology, Energy (miscellaneous), Control and Optimization, Electrical and Electronic Engineering
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Source: Scopus
Source ID: 85054989951
Research output: Contribution to journal › Review Article › Scientific › peer-review

Mixed-integer linear programming approach for global discrete sizing optimization of frame structures
This paper focuses on discrete sizing optimization of frame structures using commercial profile catalogs. The optimization problem is formulated as a mixed-integer linear programming (MILP) problem by including the equations of structural analysis as constraints. The internal forces of the members are taken as continuous state variables. Binary variables are used for choosing the member profiles from a catalog. Both the displacement and stress constraints are formulated such that for each member limit values can be imposed at predefined locations along the member. A valuable feature of the formulation, lacking in most contemporary approaches, is that global optimality of the solution is guaranteed by solving the MILP using branch-and-bound techniques. The method is applied to three design problems: a portal frame, a two-story frame with three load cases and a multiple-bay multiple-story frame. Performance profiles are determined to compare the MILP reformulation method with a genetic algorithm.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Civil Engineering, KU Leuven
Contributors: van Mellaert, R., Mela, K., Tiainen, T., Heinisuo, M., Lombaert, G., Schevenels, M.
Number of pages: 15
Pages: 579–593
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ASJC Scopus subject areas: Control and Systems Engineering, Software, Computer Science Applications, Computer Graphics and Computer-Aided Design, Control and Optimization
Keywords: Discrete optimization, Frame structures, Global optimization, Mixed-integer linear programming, Sizing optimization

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Source ID: 85026724545
Research output: Contribution to journal › Article › Scientific › peer-review

Locomotion of light-driven soft microrobots through a hydrogel via local melting

Soft mobile microrobots whose deformation can be directly controlled by an external field can adapt to move in different environments. This is the case for the light-driven microrobots based on liquid-crystal elastomers (LCEs). Here we show that the soft microrobots can move through an agarose hydrogel by means of light-controlled travelling-wave motions. This is achieved by exploiting the inherent rise of the LCE temperature above the melting temperature of the agarose gel, which facilitates penetration of the microrobot through the hydrogel. The locomotion performance is investigated as a function of the travelling-wave parameters, showing that effective propulsion can be obtained by adapting the generated motion to the specific environmental conditions.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Chemistry and Bioengineering, Max Planck Institute for Intelligent Systems, Max Planck ETH Center for Learning Systems, University of Florence, CNR-INO, University of Stuttgart
Contributors: Palagi, S., Mark, A. G., Melde, K., Qiu, T., Zeng, H., Parmeggiani, C., Martella, D., Wiersma, D. S., Fischer, P.
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ISBN (Electronic): 9781538603468
ASJC Scopus subject areas: Mechanical Engineering, Artificial Intelligence, Control and Optimization
Keywords: Hydrogels, Liquid-crystal elastomers (LCEs), Soft microrobots
DOIs:
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Source: Scopus
Source ID: 85030234395
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Pneumatically actuated elastomeric device for simultaneous mechanobiological studies & live-cell fluorescent microscopy

In this study, we demonstrate the functionality and usability of a compact, pneumatically actuated, elastomeric stimulation device for mechanobiological studies. The soft mechatronic device enables high-resolution live-cell confocal fluorescent imaging during equiaxial stretching. Several single cells can be tracked and imaged repeatedly after stretching periods. For demonstration, we provide image based analysis of dynamic change of the cell body and the nucleus area and actin fiber orientation during mechanical stimulation of mouse embryonic fibroblast (MEF) cells. Additionally, we present the characteristics of the device utilizing computational simulations and experimental validation using a particle tracking method for strain field analysis.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Faculty of Biomedical Sciences and Engineering, Research group: Micro and Nanosystems Research Group, BioMediTech, Biomedical Sciences and Technology
Contributors: Kreutzer, J., Viehrig, M., Maki, A., Kallio, P., Rahikainen, R., Hytönen, V.
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ASJC Scopus subject areas: Mechanical Engineering, Artificial Intelligence, Control and Optimization
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Bibliographical note
INT=tut-bmt,"Viehrig, Marlitt"
Source: Scopus
Source ID: 85030222654
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Secure and connected wearable intelligence for content delivery at a mass event: A case study
Presently, smart and connected wearable systems, such as on-body sensors and head-mounted displays, as well as other small form factor but powerful personal computers are rapidly pervading all areas of our life. Motivated by the opportunities that next-generation wearable intelligence is expected to provide, the goal of this work is to build a comprehensive understanding around some of the user-centric security and trust aspects of the emerging wearable and close-to-body wireless systems operating in mass events and under heterogeneous conditions. The paper thus intends to bring the attention of the research community to this emerging paradigm and discuss the pressing security and connectivity challenges within a popular consumer context. Our selected target scenario is that of a sports match, where wearable-equipped users may receive their preferred data over various radio access protocols. We also propose an authentication framework that allows for delivery of the desired content securely within the considered ecosystem.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Electronics and Communications Engineering, Pervasive Computing, Research group: Emerging Technologies for Nano-Bio-Info-Cogno, Research area: Information security, Research group: Wireless Communications and Positioning, ITMO University
Contributors: Ometov, A., Solomitckii, D., Olsson, T., Bezzateev, S., Shchesniak, A., Andreev, S., Harju, J., Koucheryavy, Y.
Publication date: 1 Jun 2017
Peer-reviewed: Yes

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ASJC Scopus subject areas: Computer Networks and Communications, Control and Optimization, Instrumentation
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http://urn.fi/URN:NBN:fi:tty-201710091990
Source: Scopus
Source ID: 85029506641
Research output: Contribution to journal › Article › Scientific › peer-review

Determining maximum MPP-tracking sampling frequency for input-voltage-controlled PV-interfacing converter
A maximum-power-point tracking (MPPT) algorithm is essential in all controllers of solar power electronic converters due to the nonlinear current-voltage characteristics of a photovoltaic generator. One of the most widely utilized algorithms are perturbative MPPT techniques such as perturb and observe and incremental conductance methods due to their simple implementation with relatively good tracking performance. However, in order to optimize the performance of such algorithms, the design parameters - sampling frequency and perturbation step size - need to be designed in respect to interfaced power electronic converter. Recent studies have provided state-of-art MPP-tracking design rules for single and two-stage grid-connected PV systems. Unfortunately, the analysis of those studies does not provide analytical results for PV power transient response under feedback-controlled converters. This paper provides reduced-order transfer functions for the converters equipped with either I-type or PID-type controllers in order to approximate the maximum sampling or

perturbation frequency for MPP-tracking algorithms. The analysis reveals the factors affecting the transient behavior similarly as in open-loop converter providing valuable tools for optimizing MPP-tracking perturbation frequency design.

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MoE publication type: A4 Article in a conference publication
Organisations: Electrical Energy Engineering, Research area: Power engineering, Ariel University
Contributors: Kivimäki, J., Sitbon, M., Kolesnik, S., Kuperman, A., Suntio, T.
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ASJC Scopus subject areas: Control and Systems Engineering, Electrical and Electronic Engineering, Energy Engineering and Power Technology, Control and Optimization
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http://urn.fi/URN:NBN:fi:tty-201802141221
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

A reformulation of the internal model principle using factorization approach

General information
Publication status: Published
Organisations: Mathematics, Research group: Computer Science and Applied Logics
Contributors: Laakkonen, A. A. P.
Publication date: 2017
Peer-reviewed: Unknown
Event: Paper presented at CDPS 2017, Workshop on Control of Distributed Parameter Systems, Bordeaux, France, .
ASJC Scopus subject areas: Control and Optimization
Research output: Other conference contribution › Paper, poster or abstract › Scientific

Asymptotics for infinite systems of differential equations
This paper investigates the asymptotic behavior of solutions to certain infinite systems of ordinary differential equations. In particular, we use results from ergodic theory and the asymptotic theory of C0-semigroups to obtain a characterization, in terms of convergence of certain Cesàro averages, of those initial values which lead to convergent solutions. Moreover, we obtain estimates on the rate of convergence for solutions whose initial values satisfy a stronger ergodic condition. These results rely on a detailed spectral analysis of the operator describing the system, which is made possible by certain structural assumptions on the operator. The resulting class of systems is sufficiently broad to cover a number of important applications including, in particular, both the so-called robot rendezvous problem and an important class of platoon systems arising in control theory. Our method leads to new results in both cases.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Research group: Computer Science and Applied Logics
Contributors: Paunonen, L., Seifert, D.
Number of pages: 26
Pages: 1153-1178
Publication date: 2017
Peer-reviewed: Yes

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Volume: 55
Issue number: 2
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ASJC Scopus subject areas: Control and Optimization, Applied Mathematics
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URLs:

http://urn.fi/URN:NBN:fi:tty-201709191896
Source: Scopus
Source ID: 85018956934
Research output: Contribution to journal › Article › Scientific › peer-review

Robust controllers for regular linear systems with infinite-dimensional exosystems

We construct two error feedback controllers for robust output tracking and disturbance rejection of a regular linear system with nonsmooth reference and disturbance signals. We show that for sufficiently smooth signals the output converges to the reference at a rate that depends on the behavior of the transfer function of the plant on the imaginary axis. In addition, we construct a controller that can be designed to achieve robustness with respect to a given class of uncertainties in the system, and we present a novel controller structure for output tracking and disturbance rejection without the robustness requirement. We also generalize the internal model principle for regular linear systems with boundary disturbance and for controllers with unbounded input and output operators. The construction of controllers is illustrated with an example where we consider output tracking of a nonsmooth periodic reference signal for a two-dimensional heat equation with boundary control and observation, and with periodic disturbances on the boundary.

General information

Publication status: Published
MoE publication type: A1 Journal article-refereed
Organisations: Mathematics, Research group: Computer Science and Applied Logics
Contributors: Paunonen, L.
Number of pages: 31
Pages: 1567-1597
Publication date: 2017
Peer-reviewed: Yes

Publication information

Journal: SIAM Journal on Control and Optimization
Volume: 55
Issue number: 3
ISSN (Print): 0363-0129
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Scopus rating (2017): CiteScore 3.1 SJR 1.399 SNIP 1.728
Original language: English
ASJC Scopus subject areas: Control and Optimization, Applied Mathematics
Keywords: Controller Design, Feedback, Regular Linear Systems, Robust Output Regulation, Stability
Electronic versions:

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DOIs:

10.1137/16M107181X
URLs:

http://urn.fi/URN:NBN:fi:tty-201709191895
Source: Scopus
Source ID: 85021700145
Research output: Contribution to journal › Article › Scientific › peer-review

Asymptotic Behaviour of Platoon Systems

In this paper we study the asymptotic behaviour of various platoon-type systems using the general theory developed by the authors in a recent article. The aim is to steer an infinite number of vehicles towards a target configuration in which each vehicle has a prescribed separation from its neighbour and all vehicles are moving at a given velocity. More specifically, we study systems in which state feedback is possible, systems in which observer-based dynamic output feedback is required, and also a situation in which the control objective is modified to allow the target separations to depend on the vehicles' velocities. We show that in the first and third cases the objective can be achieved, but that in the second case the system is unstable in the sense that the associated semigroup is not uniformly bounded. We also present

some quantified results concerning the rate of convergence of the platoon to its limit state when the limit exists.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Mathematics, Research group: MAT Mathematical and semantic modelling, University of Oxford
Contributors: Paunonen, L., Seifert, D.
Number of pages: 7
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Publication date: Jul 2016

Host publication information
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ISBN (Electronic): 978-1-5323-1358-5
ASJC Scopus subject areas: Analysis, Control and Optimization
Keywords: Vehicle platoon, ordinary differential equations, asymptotic behaviour, state feedback, rates of convergence
Electronic versions:

Paunonen & Seifert - MTNS 2016 preprint
URLs:

http://urn.fi/URN:NBN:fi:tty-201611244796

http://hdl.handle.net/11299/181518
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Robust Regulation for First-Order Port-Hamiltonian Systems
We present a method for obtaining robust control over a first-order port-Hamiltonian system. The presented method is especially designed for controlling impedance energy-preserving port- Hamiltonian systems. By combining the stabilization results of port-Hamiltonian systems and the theory of robust output regulation for exponentially stable systems, we design a simple finite-dimensional controller for an unstable system that together with output feedback achieves robust output regulation. The method is demonstrated on an example where we implement a robust regulating controller for the one-dimensional wave equation with boundary control and observation.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Mathematics, Research group: MAT Mathematical and semantic modelling, Research group: MAT Intelligent Information Systems Laboratory
Contributors: Humaloja, J., Paunonen, L., Pohjolainen, S.
Number of pages: 6
Publication date: 2016

Host publication information
Title of host publication: Proceedings of the 15th European Control Conference, Aalborg, Denmark, June 29th - July 1st, 2016
Publisher: IEEE
ISBN (Electronic): 978-1-5090-2590-9
ASJC Scopus subject areas: Control and Optimization
Keywords: Robust output regulation, port-Hamiltonian systems
DOIs:

10.1109/ECC.2016.7810618
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Robust Regulation for Port-Hamiltonian Systems of Even Order
We present a controller that achieves robust regulation for a port-Hamiltonian system of even order. The controller is especially designed for impedance energy-preserving systems. By utilizing the stabilization results for port-Hamiltonian systems together with the theory of robust output regulation for exponentially stable systems, we construct a simple controller that solves the Robust Output Regulation Problem for an initially unstable system. The theory is illustrated on an example where we construct a controller for one- dimensional Schrödinger equation with boundary control and observation.

General information
Publication status: Published

MoE publication type: A4 Article in a conference publication
Organisations: Department of Mathematics, Research group: MAT Mathematical and semantic modelling, Research group: MAT Intelligent Information Systems Laboratory
Contributors: Humaloja, J., Paunonen, L., Pohjolainen, S.
Number of pages: 5
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Publication date: 2016

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Publisher: University of Minnesota
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ASJC Scopus subject areas: Control and Optimization
Keywords: Robust output regulation, port-Hamiltonian systems
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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Computationally efficient optimization algorithms for model predictive control of linear systems with integer inputs
The model predictive control problem of linear systems with integer inputs results in an integer optimization problem. In case of a quadratic objective function, the optimization problem can be cast as an integer least-squares (ILS) problem. Three algorithms to solve this problem are proposed in this paper. Optimality can be traded in to reduce the computation time. An industrial case study-an inverter-driven electrical drive system-is considered to demonstrate the effectiveness of the presented techniques.

General information
Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Institute for Electrical Drive Systems and Power Electronics, Technische Universitat Munchen, ABB Corporate Research Center - Switzerland
Contributors: Karamanakos, P., Geyer, T., Kennel, R.
Number of pages: 6
Pages: 3663-3668
Publication date: 16 Dec 2015

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ISBN (Electronic): 9781479978861
ASJC Scopus subject areas: Control and Systems Engineering, Modelling and Simulation, Control and Optimization
Electronic versions:

Computationally efficient optimization algorithms 2015
DOIs:

10.1109/CDC.2015.7402787
URLs:

http://urn.fi/URN:NBN:fi:tuni-202004083147
Source: Scopus
Source ID: 84961990645
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Frequency domain robust regulation of signals generated by an infinite-dimensional exosystem
This paper deals with frequency domain robust regulation of signals generated by an infinite-dimensional exosystem. The problem is formulated and the stability types are chosen so that one can generalize the existing finite-dimensional theory to more general classes of infinite-dimensional systems and signals. The main results of this article are extensions of the internal model principle, of a necessary and sufficient solvability condition for the robust regulation problem, and of Davison's simple servo compensator for stable plants in the chosen algebraic framework.

General information
Publication status: Published
MoE publication type: A1 Journal article-refereed

Organisations: Department of Mathematics, Research group: MAT Intelligent Information Systems Laboratory
Contributors: Laakkonen, P., Pohjolainen, S.
Number of pages: 28
Pages: 139-166
Publication date: 2015
Peer-reviewed: Yes

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Scopus rating (2015): CiteScore 3.5 SJR 2.017 SNIP 1.646
Original language: English
ASJC Scopus subject areas: Control and Optimization, Applied Mathematics
Keywords: Frequency domain, Infinite-dimensional exosystems, Infinite-dimensional systems, Internal model, Robust regulation
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http://www.scopus.com/inward/record.url?scp=84923923144&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84923923144
Research output: Contribution to journal › Article › Scientific › peer-review

On Robust Output Regulation for Continuous-Time Periodic Systems
We construct a controller to solve robust output tracking problem for a stable linear continuous-time periodic system on a finite-dimensional space. We begin by transforming the time-dependent plant to a time-invariant discrete-time system using the ``lifting technique''. The controller is then designed to achieve robust output tracking for the lifted system. We show that an exact solution to the control problem for a continuous-time periodic system necessarily requires an error feedback controller with an infinite-dimensional internal model. The results are illustrated with an example where robust output tracking is considered for a stable periodic scalar system.

General information
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Organisations: Department of Mathematics, Research group: MAT Mathematical and semantic modelling
Contributors: Paunonen, L.
Number of pages: 7
Publication date: 2015

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Title of host publication: 2015 Proceedings of the SIAM Conference on Control and its Applications
Publisher: SIAM, Society for Industrial and Applied Mathematics
ISBN (Electronic): 978-1-61197-407-2
ASJC Scopus subject areas: Control and Optimization, Analysis
Electronic versions:

Article
DOIs:

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URLs:

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Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Robust Regulation of SISO Systems: The Fractional Ideal Approach
We solve the robust regulation problem for single-input single-output plants by using the fractional ideal approach and without assuming the existence of coprime factorizations. In particular, we are able to formulate the famous internal model principle for stabilizable plants which do not necessarily admit coprime factorizations. We are able to give a necessary and suffcient solvability condition for the robust regulation problem, which leads to a design method for a robustly regulating controller. The theory is illustrated by examples.

General information

Publication status: Published
MoE publication type: A4 Article in a conference publication
Organisations: Department of Mathematics, Inria Saclay-Ile-de-France
Contributors: Laakkonen, P., Quadrat, A.
Number of pages: 8
Pages: 311-318
Publication date: 2015

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Publisher: SIAM, Society for Industrial and Applied Mathematics
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ASJC Scopus subject areas: Control and Optimization, Applied Mathematics
DOIs:

10.1137/1.9781611974072.43
Research output: Chapter in Book/Report/Conference proceeding › Conference contribution › Scientific › peer-review

Towards dependable automation
Automation runs the modern society and it’s critical systems. It is anetworked software product depending on the co-operation of old and new technologies.Information security for automation systems should be regarded in light ofthe most important quality required from automation—dependability. This chapterfocuses on process of developing dependable solutions for the entire lifecycle ofautomation systems. The approach includes a guideline for securing automation anda dependability model that is a data flow model extended with security and automationrequirements. Results of this analysis should be used in final requirementspecification for implementation. Dependability model is the key tool in securedevelopment lifecycle. It can be used in new product development, improving anold automation system and also during the active lifecycle of automation to manage inevitable changes occurring during the entire lifespan of automation system.

General information
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MoE publication type: A3 Part of a book or another research book
Organisations: Tampere University of Technology, Department of Automation Science and Engineering, Research area: Information Systems in Automation
Contributors: Seppälä, J., Salmenperä, M.
Number of pages: 21
Pages: 229-249
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ASJC Scopus subject areas: Computer Science Applications, Control and Systems Engineering, Mechanical Engineering, Control and Optimization
DOIs:

10.1007/978-3-319-18302-2_15
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http://www.scopus.com/inward/record.url?scp=84934873164&partnerID=8YFLogxK (Link to publication in Scopus)
Source: Scopus
Source ID: 84934873164
Research output: Chapter in Book/Report/Conference proceeding › Chapter › Scientific › peer-review

A hybrid optimization grey model based on segmented gra and multi-strategy contest for short-term power load forecasting
In this paper, a hybrid grey model with both internal and external optimization is proposed to forecast the short-term power load which has the characteristics of nonlinear fluctuation and random growth. The internal optimization consists of modeling feasibility test and parameter a correction. The external optimization includes three aspects. First, the original series are selected from different viewpoints to construct different forecasting strategies. Second, the predicted day is divided into several smooth segments for separate forecasting. Finally, the different forecasting strategies are

implemented respectively in the different segments through grey correlation contest. A practical application verifies that the proposed model has a higher forecasting accuracy and the independency on the choice of initial value.

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Contributors: Min, J., Xiang, Z., Zhiming, Z., Tentzeris, M. M.
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Condition monitoring of storage batteries in telecom power systems-crisp vs. soft computing methodology
The storage battery is the most important and decisive component in a telecom DC UPS system, determining its reliability and availability performance. The deployment of valve-regulated lead-acid (VRLA) batteries into telecom networks started an era of unbelievable problems and gradual deterioration of credibility. Battery condition monitoring has become a necessity, and not just a way to boost reliability. The behavior of a storage battery resembles, in many respects, that of human behavior, making it difficult or almost impossible to draw viable conclusions or to predict future behavior from the data obtainable. This paper makes a survey of available methods and problems to assess the state-of-health of VRLA batteries and proposes a suitable method based on soft computing principles.

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Soft computing-based controller design for a telecom rectifier

Presents controller design for a telecommunications rectifier based on analogue, digital and fuzzy logic approaches. The required output characteristics contain three modes of operation-constant-voltage, modified constant-power and constant-current. The proposed analogue solution is well proven in practical use and shows excellent performance. The digital solution is simulated and preliminary results predict its applicability. The fuzzy logic solution is outlined for constant-voltage and overload controllers. Preliminary simulations are promising but further optimization must be carried out.

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