Indirect NOₓ emission monitoring in natural gas fired boilers

New emission regulations will increase the need for inexpensive NOₓ emission monitoring solutions also in smaller power plants. The objective in this study is to find easily maintainable and transparent but still valid models to predict NOₓ emissions in natural gas fired hot water boilers utilizing existing process instrumentation. With a focus on long-term applicability in practical installations, the performance of linear regression is compared in two municipal 43 MW boilers with three widely used nonlinear methods: multilayer perceptron, support vector regression, and fuzzy inference system. The linear models were the most applicable providing the best estimation results (relative error of 1 applications in practise. However, each boiler model should be identified individually.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Authors: Korpela, T., Kumpulainen, P., Majanne, Y., Häyrinen, A., Lautala, P.
Keywords: (Combustion, Estimation, Modelling, Monitoring, Natural gas, NO, Soft sensor)
Number of pages: 15
Pages: 11-25
Publication date: 1 Aug 2017
Peer-reviewed: Yes
ASJC Scopus subject areas: Control and Systems Engineering, Computer Science Applications, Applied Mathematics, Electrical and Electronic Engineering

Publication information
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Ratings:
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Scopus rating (2015): 1.194 2.091
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Publication Forum (2015): 2
Scopus rating (2014): 1.323 2.626
Web of Science (2014): 1.814 2.213 7.9 0.348 0.00786 0.717
Publication Forum (2014): 1
Scopus rating (2013): 1.433 3.278
Publication Forum (2013): 1
Scopus rating (2012): 1.267 3.118
Publication Forum (2012): 1
Scopus rating (2011): 1.544 2.911
Scopus rating (2010): 1.343 2.745
Scopus rating (2008): 1.432 2.917
Scopus rating (2007): 1.105 2.169
Scopus rating (2006): 0.909 1.894
Scopus rating (2005): 0.579 1.595
Scopus rating (2004): 0.476 1.304
Scopus rating (2003): 0.658 1.33
Scopus rating (2002): 0.481 1.05
Scopus rating (2001): 0.516 0.995
Scopus rating (2000): 0.457 0.86
Scopus rating (1999): 0.358 0.843
Original language: English
DOIs: 10.1016/j.conengprac.2017.04.013
Source: Scopus
Source-ID: 85019718306
Research output: Scientific - peer-review › Article
From Iterative Balance Models to Directly Calculating Explicit Models for Real-time Process Optimization and Scheduling

Optimal utilization of complex processes involves real-time operational optimization and scheduling, especially in cases where the production line consists of both continuous and batch operated unit processes. This kind of real-time optimization requires process models which can be computed significantly faster than real-time. Iterative balance calculation is typically far too slow for these cases. This paper presents a method for converting an iterative balance model to a directly calculating model suitable for online process optimization. The approach is demonstrated with the first unit process in the copper smelting line, the flash smelting furnace (FSF). The method consisted of formulating an equation group based on the constrained FSF HSC-Sim model and solving the unknown parameters and static states with use of a symbolic calculation software. The solution was implemented as a function whose calculation time fulfilled the requirements for scheduling use.

Menetelmä ja laitteisto selluloosapitoisten materiaalien fibrilloimiseksi; Förfarande och anordning för fibrillering av cellulosahaltiga materialer
Robust data reconciliation of combustion variables in multi-fuel fired industrial boilers

This paper introduces an application of simultaneous nonlinear data reconciliation and gross error detection for power plants utilizing a complex but computationally light first principle combustion model. Element and energy balances and robust techniques introduce nonlinearity and the consequent optimization problem is solved using nonlinear optimization. Data reconciliation improves estimation of process variables and enables improved sensor quality control and identification of process anomalies. The approach was applied to an industrial 200 MWth fluidized bed boiler combusting wood, peat, bark, and slurry. The results indicate that the approach is valid and is able to perform in various process conditions. As the combustion model is generic, the method is applicable in any boiler environment.

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Authors: Korpela, T., Suominen, O., Majanne, Y., Laukkanen, V., Lautala, P.
Keywords: (Data reconciliation, Diagnostics, Estimation, Gross error detection, Monitoring, Power plant)
Number of pages: 15
Pages: 101-115
Publication date: 21 Jul 2016
Peer-reviewed: Yes
ASJC Scopus subject areas: Control and Systems Engineering, Electrical and Electronic Engineering, Applied Mathematics, Computer Science Applications

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Journal: Control Engineering Practice
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ISSN (Print): 0967-0661
Ratings:
Publication Forum (2017): 2
Scopus rating (2016): 1.287 2.156
Publication Forum (2016): 2
Scopus rating (2015): 1.194 2.091
Web of Science (2015): 1.83 2.218 7.8 0.214 0.00881 0.786
Publication Forum (2015): 2
Scopus rating (2014): 1.323 2.626
Web of Science (2014): 1.814 2.213 7.9 0.348 0.00786 0.717
Publication Forum (2014): 1
Scopus rating (2013): 1.433 3.278
Publication Forum (2013): 1
Scopus rating (2012): 1.267 3.118
Publication Forum (2012): 1
Scopus rating (2011): 1.544 2.911
Functionality Testing of Water Pressure and Flow Calculation for Dynamic Power Plant Modelling

Water pressure and flow rate calculation in dynamic boiler models is challenging because of stiff system dynamics meaning that time constants of model states vary by several orders of magnitude. Furthermore, strong interconnections between pressures and flow variables may cause instability problems in simulation runs. This study presents a method to implement and test dynamic thermal power plant water-steam system models. A dynamic water-steam system model is presented. The model is applied for testing of the functionality of the presented computation model. Computational performance was tested using different numerical solvers. Also sensitivity to changes in initial values of system states and model parameters was tested. The results indicate that a workable way to make flexible models was found.
Gain-Scheduled Composite Nonlinear Feedback Control of an Exothermic Chemical Reactor

This paper studies gain-scheduled composite nonlinear feedback (CNF) control of a continuous stirred tank reactor (CSTR). Inside the reactor, an exothermic chemical reaction occurs, which is commanded from high to low residual concentration. During the transition, the reaction dynamics change through stable-unstable-stable chain while the residual concentration decreases. Therefore, appropriate cooling is necessary to stabilize the reaction, and to prevent a thermal runaway and overheating of the CSTR. A full-state gain-scheduled CNF controller is designed for adjusting the coolant temperature of the CSTR. A traditional gain-scheduled cascade controller and a gain-scheduled model predictive controller (MPC) are also fabricated for comparison. The simulation results show that the closed-loop system using CNF controller is able to offer the best tracking performance as measured by the integral-of-absolute-error (IAE) criterion. In addition, the CNF controller needs fewer scheduled tuning parameters as opposed to the cascade structure.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering, Research area: Information Systems in Automation, Research area: Dynamic Systems
Authors: Pyrhönen, V., Koivisto, H.
Keywords: (Constrained control, Process control, Chemical process control)
Number of pages: 7
Publication date: 2016
Model based NOx emission monitoring in natural gas fired hot water boilers
Due to new emission regulations, coverage of monitoring requirements extends to new boiler classes. In Europe, Industrial Emission Directive brings new 15-50 MW boilers under the directive in special cases, so inexpensive NOx emission monitoring tools are appreciated. This paper presents models to estimate NOx emission in two similar natural gas fired municipal hot water boilers. The models utilize online process measurements also available in relatively simple set-ups. In the context, the performance of linear regression model and nonlinear neural network model are introduced. Despite the similarity, the results state that the examined boilers behave differently in terms of linearity and emission levels. Therefore, every boiler should be identified separately to exploit the simplest models in practical installations.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Authors: Korpela, T., Kumpulainen, P., Majanne, Y., Häyrinen, A.
Pages: 385-390
Publication date: 11 Dec 2015

Host publication information
Title of host publication: 9th IFAC Symposium on Control of Power and Energy Systems CPES 2015 — New Delhi, India, 9—11 December 2015

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Publisher: Elsevier
Volume: 48
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DOIs: 10.1016/j.ifacol.2015.12.409

Bibliographical note
9th IFAC Symposium on Control of Power and Energy Systems CPES 2015 — New Delhi, India, 9—11 December 2015
Edited By Sukumar Mishra
Research output: Scientific - peer-review › Conference contribution

Monitoring of spraying in semi-dry desulfurization processes in coal fired power plants
The overall objective of the study is to improve usability and efficiency of desulphurization processes by providing assistance for plant operators by indicating arising issues. This paper introduces an indirect method to monitor spraying in semi-dry desulphurization processes, which is based on energy balance and first principle models. The method can e.g. be used to estimate flue gas exit temperature of the reactor, which is the main control variable in the process, and slurry flows to reactors. The temperature estimate indicates what should be the exit temperature if spraying is functioning properly. The method was tested with process data collected from an industrial power plant, and the simulation results state that the method is able to predict the reactor exit temperature by error of typically less than few degrees Celsius regardless of the process state.

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Authors: Korpela, T., Majanne, Y., Salminen, O., Laari, A., Björkqvist, T.
Pages: 403–408
Publication date: 11 Dec 2015

Host publication information
Title of host publication: 9th IFAC Symposium on Control of Power and Energy Systems CPES 2015 — New Delhi, India, 9—11 December 2015

Publication series
Name: IFAC-PapersOnLine
Publisher: Elsevier
Volume: 48
No.: 30
Real Time Monitoring of Environmental Efficiency of Power Plants

Today total environmental impacts of power production are a subject of emerging interest. Operation of power plants presents direct and indirect impacts to the environment. Direct impacts consist of instant emissions due to the operation of power plants and indirect impacts are originated from the production and transportation of fuels and waste handling. The direct emissions are monitored with Continuous Emission Monitoring Systems (CEMS) but indirect Life Cycle Impacts (LCI) are typically assessed only once during the design phase of process properties such as applied combustion technology and fuels. This paper introduces a procedure for a real time monitoring of total environmental impacts of power plants. The monitoring system aggregates direct and indirect impacts as a total environmental efficiency of the power plant. The procedure can be used e.g. for designing the environmentally friendly operation strategy for the power plant and sustainable purchasing of fuels. This project is a part of the MMEA (Measurement Monitoring and Environmental Assessment) research program coordinated by CLEEN Ltd and funded by the Finnish Funding Agency for Innovation TEKES.

Preparation of Supercapacitors on Flexible Substrates with Electrodeposited PEDOT/Graphene Composites

Composite films consisting of poly(3,4-ethylenedioxythiophene) (PEDOT) and graphene oxide (GO) were electrochemically polymerized by electrooxidation of EDOT in ionic liquid (BMIMBF₄) onto flexible electrode substrates. Two polymerization approaches were compared, and the cyclic voltammetry (CV) method was found to be superior to potentiostatic polymerization for the growth of PEDOT/GO films. After deposition, incorporated GO was reduced to rGO by a rapid electrochemical method of repetitive cathodic potential cycling, without using any reducing reagents. The films were characterized in 3-electrode configuration in BMIMBF₄. Symmetric supercapacitors with aqueous electrolyte were assembled from the composite films and characterized through cyclic voltammetry and galvanostatic discharge tests. It was shown that PEDOT/rGO composites have better capacitive properties than pure PEDOT or the unreduced composite film. The cycling stability of the supercapacitors was also tested, and the results indicate that the specific capacitance still retains well over 90% of the initial value after 2000 consecutive charging/discharging cycles. The supercapacitors were demonstrated as energy storages in a room light energy harvester with a printed organic solar cell and printed...
The aim of the article is to analyse the changes in Cuban energy system. It uses decomposition analysis to reveal the impacts of the changes in key drivers of energy consumption and CO2 emissions. The Cuban Energy Revolution, which was started in 2006, was the policy response to the local energy crisis; oil imports caused serious balance of payments problems, the old centralised electricity production system was inefficient and hurricanes caused widespread blackouts. The Energy Revolution has been quite successful in changing the energy use patterns in Cuban households. Switch from kerosene to electricity in cooking and using energy saving pressure cookers have had an effect on energy efficiency. In addition, the decentralisation of electricity production...
has increased the reliability of supply and improved the efficiency when new smaller scale power plants have replaced older technology. The energy revolution has, so far not had much impact on energy use in industry, transport and agriculture, which are the areas where the future policies should be directed.

On improvement of transient stage of composite nonlinear feedback control using arbitrary order set point filters

This paper studies the generalization of composite nonlinear feedback (CNF) control using arbitrary order set point filters, which focus on the initial stage of the transient response. The set point filters can be used to provide more performance by shortening the rise and settling times of the control system. Furthermore, the filters operate outside the feedback loop, and
hence, they do not sacrifice loop robustness. The new method is illustrated by a benchmark problem found in an open literature. The simulation results show that the proposed method improves the set point response more than 10% in terms of settling time.

Composite Nonlinear Feedback Control of a Chemical Reactor
This paper studies the application of composite nonlinear feedback (CNF) control for a continuous time stirred tank reactor. Inside the reactor, an exothermic chemical reaction occurs, which requires cooling when concentration is commanded from low to high conversion rate to prevent a thermal runaway. A full-state CNF controller is designed for adjusting the temperature of the cooling jacket using concentration and temperature measurements. A continuous time gain-scheduled cascade controller, as well as a model predictive controller (MPC) is also fabricated for comparison. The gain-scheduled cascade controller has a proportional-integral (PI) controller as a primary loop controller, and a P-controller as a secondary loop controller. The simulation results show that the CNF controller is able to offer the best overall tracking performance as measured by the integral-of-absolute-error (IAE) criterion. In addition, the CNF controller does not need gain-scheduling for tuning purposes; the CNF controller is capable of changing its tuning as a function of control error only.

Copper Production as an Application of Optimization and Scheduling
Copper production in a copper smelter is a process comprised of batch and continuous production tasks. Typically, subprocesses have been operated in a locally optimal way though significant interdependencies exist. In general, copper production presents a harsh environment where production is often disturbed by unforeseen events and frequent maintenance operations. Optimization of production is further complicated by the significantly differing timescales with recycling of some materials. This work presents first the main production tasks related to copper production and then details requirements and procedures in modelling the full task with the goal of producing models suitable for a global
scheduling solution. The main scheduling decision variables are detailed and a simplified example of scheduling two converters is included. The scheduling and optimization is to provide operators with advice on timings and resource use to maximize equipment use and production throughput. The solution structure may be viewed as a combination of scheduling and predictive control techniques. By considering material inputs over the complete production cycle, the optimization is to provide improvements especially in impurity control.

A Method and an Apparatus for Producing Nanocellulose

Described herein is nanocellulose produced by introducing a mixture of cellulose based fiber raw material and water through a refining gap, having a width smaller than 0.1 mm. In the refining gap, the fiber raw material is subjected to processing forces varying in the direction of introducing said mixture, by means of refining zones provided in the gap one after each other in the feeding direction, whereby the refining surfaces differ in surface patterning and/or surface roughness. The mixture of fiber raw material and water is guided past the refining surfaces in the feeding direction to different locations in the refining zone by by-pass channels provided in the stator. The width of the refining gap is maintained by the combined effect of the feeding pressure of the mixture of fiber raw material and water fed into the refining gap and the axial force of the rotor.

General information
Modelling of NOx Emissions in Natural Gas Fired Hot Water Boilers

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Authors: Kumpulainen, P., Korpela, T., Majanne, Y., Häyrinti, A.
Pages: 100-108
Publication date: 2015

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Volume: 517
ISBN (Print): 978-3-319-23981-1
ISBN (Electronic): 978-3-319-23983-5

Publication series
Name: Communications in Computer and Information Science
Publisher: Springer
Volume: 517
DOIs: 10.1007/978-3-319-23983-5_10
Links: https://link.springer.com/chapter/10.1007/978-3-319-23983-5_10?no-access=true
http://www.scopus.com/record/display.uri?eid=2-s2.0-84951732391&origin=resultslist&sort=plf-f&src=s&s&id=5827786001E1F7B2333C1F52273E17331.FZg2ODcsJC9ArCe8WOZPvA%3a80&sot=autdocs&sdt=autdocs&s=18&s=AU-ID%285585194796329%29&relpos=0&citeCnt=0&searchTerm=

Research output: Scientific - peer-review › Conference contribution

Monitoring of flue gas desulphurization process in coal fired power plants

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Authors: Korpela, T., Majanne, Y., Björkqvist, T., Salminen, O.
Number of pages: 6
Pages: 1-6
Publication date: 2015

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Title of host publication: Automaatio XXI seminaari
Place of publication: Helsinki
Editor: Jämsä-Jounela, S.
OPC UA security for protecting substation and control center data communication in the distribution domain of the smart grid

The distribution domain of the smart grid incorporates advantages of the newest substation automation standards in order to enhance distribution network automation. State-of-the-art distribution automation solutions use the public Internet for exchanging data between substation and control center. This presents challenges for cybersecurity, particularly for critical data determining distribution network operation. Therefore, Internet communication between substation and control center should be carried out via a secure communication protocol. OPC Unified Architecture (UA) is an interoperable communication standard supports Internet protocols from one hand and obtains benefits from mature built-in security mechanisms from other hand. This paper describes a solution for secure data transmission between modern substation and control center over the Internet. In this approach, circuit breaker position data is chosen as the data example that is defined in respect to the IEC 61850 data model and securely transmitted to OPC UA client application at remote control center by employing the OPC UA security architecture functions.
Voimalaitosten reaaliaikainen ympäristövalikutusten monitorointi

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering, Research area: Measurement Technology and Process Control, Suomen ympäristökeskus SYKE - Finnish Environment Institute, IndMeas Oy, Helen Oy
Authors: Majanne, Y., Korpela, T., Judl, J., Koskela, S., Laukkanen, V., Häyrinen, A., Salminen, O.
Number of pages: 6
Pages: 1-6
Publication date: 2015

Host publication information
Title of host publication: Automaatio XXI seminaari
Publisher: Suomen Automaatioseura
Editor: Jämsä-Jounela, S.
ISBN (Print): 978-952-5183-46-7

Adaptive mass flow sensor calibration method for crushing circuits

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Automation Science and Engineering
Authors: Väyrynen, T., Itävuo, P., Jaatinen, A., Vilkko, M., Peltonen, M.
Number of pages: 6
Pages: 1-6
Publication date: 2014

Host publication information
Title of host publication: Proceedings of Comminution ’14, April 7-10, 2014, Cape Town, South Africa
Links: http://www.min-eng.com/comminution14/paps.html

Bibliographical note
Contribution: organisation=ase,FACT1=1<br/>Portfolio EDEND: 2014-12-20
Source: researchoutputwizard
Source-ID: 1715
Research output: Scientific › Conference contribution

Strategies for size reduction control in cone crushers

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Automation Science and Engineering
Authors: Itävuo, P., Väyrynen, T., Vilkko, M., Jaatinen, A.
Number of pages: 7
Tight feed-hopper level control in cone crushers

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering, Smart Energy Systems (SES)
Authors: Itävuo, P., Väyrynen, T., Vilkko, M., Jaatinen, A.
Number of pages: 10
Pages: 1-10
Publication date: 2014

Tuning of a dynamic boiler model using a nonlinear multivariable optimisation method

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering
Authors: Yli-Fossi, T.
Number of pages: 6
Pages: 426-432
Publication date: 2014
Broadband Methods for Online Grid Impedance Measurement

**General information**
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering, Smart Energy Systems (SES)
Authors: Roinila, T., Vilkko, M., Sun, J.
Number of pages: 6
Pages: 3003-3010
Publication date: 2013

**Host publication information**
Title of host publication: 2013 IEEE Energy Conversion Congress & Exposition ECCE, Denver Colorado, USA; September 15-19, 2013
Place of publication: Piscataway
Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Print): 978-1-4799-0336-8

**Publication series**
Name: IEEE Energy Conversion Congress and Exposition
DOI: 10.1109/ECCE.2013.6647093

**Bibliographical note**
Contribution: organisation=ase,FACT1=1<br/>Publisher name: Institute of Electrical and Electronics Engineers IEEE
Source: researchoutputwizard
Source-ID: 3283
Research output: Scientific - peer-review › Conference contribution

Dynamisten voimalaitosmallien parametrien määrittäminen ja virittäminen

**General information**
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering
Authors: Yli-Fossi, T.
Number of pages: 6
Pages: 1-6
Publication date: 2013

**Host publication information**
Title of host publication: Proceedings of Automaatio XX-seminaari, Automation and systems without borders - beyond future, 21.-22.5.2013, Helsinki
Publisher: Suomen Automaatioseura ry
Editor: Vilkko, M.
ISBN (Print): 978-952-5183-44-3

**Publication series**
Name: SAS julkaisusarja
No.: 42
ISSN (Print): 1455-6502

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Contribution: organisation=ase,FACT1=1<br/>Publisher name: Suomen Automaatioseura ry
Source: researchoutputwizard
Source-ID: 3766
Research output: Scientific - peer-review › Conference contribution

Dynamic modeling and simulation of power plants with biomass as a fuel

**General information**
State: Published
Ministry of Education publication type: A3 Part of a book or another research book
Huokosen keraamin karakterisointi sähköisellä herätteellä

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Materials Science, Department of Automation Science and Engineering
Authors: Järveläinen, M., Salpavaara, T., Seppälä, S., Roinila, T., Vilkko, M., Levänen, E.
Number of pages: 6
Pages: 1-6
Publication date: 2013

Host publication information
Title of host publication: Proceedings of Automaatio XX-seminaari, Automation and systems without borders - beyond future, 21.-22.5.2013, Helsinki
Publisher: Suomen Automaatioseura
Editor: Vilkko, M.
ISBN (Print): 978-952-5183-44-3

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Bibliographical note
Contribution: organisation=mol,FACT1=0.5<br/>Contribution: organisation=ase,FACT2=0.5<br/>Portfolio EDEND: 2013-11-29<br/>Publisher name: Suomen Automaatioseura
Source-ID: 2409
Research output: Scientific - peer-review › Conference contribution

Introduction to Fast Frequency-Response Measurement in Micro and Nano Technology

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Automation Science and Engineering
Authors: Roinila, T., Kai, L., Wen-ming, X., Li-hui, L., Yu, X., Hui-guo, Z., Vilkko, M.
Number of pages: 7
Pages: 24-30
Publication date: 2013
Peer-reviewed: Yes

Publication information
Local compression behaviour of moist wood at quasi static state

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Automation Science and Engineering, Department of Engineering Design
Authors: Björkqvist, T., Moilanen, C., Saarenrinne, P., Koivisto, J., Miksic, A., Alava, M., Salminen, L., Engberg, B. A.
Number of pages: 2
Pages: 47-48
Publication date: 2013

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Title of host publication: 8th International Fundamental Mechanical Pulp Research Seminar, 29 - 31 January, 2013, Åre, Sweden

Publication series
Name: International Fundamental Mechanical Pulp Research Seminar

Bibliographical note
Contribution: organisation=ase,FACT1=1<br/>Portfolio EDEND: 2013-12-29<br/>Publisher name: Changshu Ligong Xueyuan
Source: researchoutputwizard
Source-ID: 3279
Research output: Scientific › peer-review › Article

Measuring Resistive Characteristics of Silicon Nanowire by Applying Electrostatic Tensile Device and Broadband Test Signal

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering, Integrated Technologies for Tissue Engineering Research (ITTE), Smart Energy Systems (SES)
Number of pages: 4
Pages: 23-26
Publication date: 2013

Host publication information
Title of host publication: Nanotechnology 2013: Advanced Materials, CNTs, Particles, Films and Composites Nanotech, Conference & Expo 2013, May 12-16, 2013 Washington, DC
Publisher: Nano Science and Technology Institute
ISBN (Print): 978-1-4822-0581-7

Publication series
Name: Nanotechnology Conference and Expo
Publisher: Nano Science and Technology Institute
Monitoring of CO2 emissions in coal fired power plants

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering
Authors: Uotila, T., Korpela, T., Majanne, Y.
Number of pages: 6
Pages: 1-6
Publication date: 2013

Host publication information
Title of host publication: Proceedings of Automaatio XX-seminaari, Automation and systems without borders - beyond future, 21.-22.5.2013, Helsinki
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Name: SAS julkaisusarja
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Contribution: organisation=ase,FACT1=1<br/>Portfolio EDEND: 2013-10-29<br/>Publisher name: Suomen Automaatioseura ry
Source: researchoutputwizard
Source-ID: 3600
Research output: Scientific - peer-review › Conference contribution

On frequency-response measurements of power-electronic systems applying MIMO identification techniques

General information
State: Published
Ministry of Education publication type: A1 Journal article-refereed
Organisations: Department of Electrical Engineering, Department of Automation Science and Engineering, Smart Energy Systems (SES)
Authors: Roinila, T., Huusari, J., Vilkko, M.
Number of pages: 7
Pages: 5270-5276
Publication date: 2013
Peer-reviewed: Yes

Publication information
Journal: IEEE Transactions on Industrial Electronics
Volume: 60
Issue number: 11
ISSN (Print): 0278-0046
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Scopus rating (2016): 2.742 3.696
Publication Forum (2016): 3
Web of Science (2015): 6.383 5.985 4.7 1.081 0.07119 1.753
Online Grid Impedance Measurement Using Discrete-Interval Binary Sequence Injection

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering, Smart Energy Systems (SES)
Authors: Roinila, T., Vilkko, M., Sun, J.
Number of pages: 8
Pages: 1-8
Publication date: 2013

Host publication information
Title of host publication: 2013 IEEE 14th Workshop on Control and Modeling for Power Electronics COMPEL, The University of Utah, Salt Lake City, Utah, USA June 23 - 26, 2013
Place of publication: Piscataway
Publisher: Institute of Electrical and Electronics Engineers IEEE
ISBN (Print): 978-1-4673-4914-7

Publication series
Name: IEEE Workshop on Control and Modeling for Power Electronics
ISSN (Print): 1093-5142
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10.1109/COMPEL.2013.6626407

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Contribution: organisation=ase,FACT1=1
Publisher name: Institute of Electrical and Electronics Engineers IEEE
Source: researchoutputwizard
Source-ID: 3282
Profililehtinen työkurssi osana ei-parametrisen mallinnuksen opetusmenetelmiä

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering
Authors: Roinila, T., Vilkko, M., Taskinen, A.
Number of pages: 6
Pages: 1-6
Publication date: 2013

Host publication information
Title of host publication: Proceedings of Automaatio XX-seminaari, Automation and systems without borders - beyond future, 21.-22.5.2013, Helsinki
Publisher: Suomen Automaatioseura ry
Editor: Vilkko, M.
ISBN (Print): 978-952-5183-44-3

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Name: SAS julkaisusarja
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Bibliographical note
Contribution: organisation=ase,FACT1=1<br/>Portfolio EDEND: 2013-11-29<br/>Publisher name: Suomen Automaatioseura ry
Source: researchoutputwizard
Source-ID: 3284
Research output: Scientific - peer-review › Conference contribution

Radial compression behavior of Norway spruce at high strain-rate

General information
State: Published
Ministry of Education publication type: B3 Non-refereed article in conference proceedings
Organisations: Department of Automation Science and Engineering, Department of Engineering Design
Authors: Moilanen, C., Björkqvist, T., Saarenrinne, P., Engberg, B. A., Salminen, L.
Number of pages: 2
Pages: 10-11
Publication date: 2013

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Title of host publication: 8th International Fundamental Mechanical Pulp Research Seminar, 29 - 31 January, 2013, Åre, Sweden

Publication series
Name: International Fundamental Mechanical Pulp Research Seminar

Bibliographical note
Contribution: organisation=ede,FACT1=0.5<br/>Contribution: organisation=ase,FACT2=0.5<br/>Portfolio EDEND: 2013-11-29
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Research output: Scientific › Conference contribution

Teollisuusvoimalaitoksen liukuva vastapaineen säätö

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering
Authors: Majanne, Y., Maasalo, M., Nyman, J.
On-line data reconciliation as a tool to improve the environmental efficiency assessment in power plant environment

General information
State: Published
Ministry of Education publication type: A4 Article in a conference publication
Organisations: Department of Automation Science and Engineering
Authors: Huovinen, M., Laukkanen, V., Korpela, T.
Number of pages: 6
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Publication date: 2012

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Title of host publication: 8th Power Plant & Power System Control Symposium, PPPSC 2012, 2-5 September 2-5, 2012, Toulouse, France
Place of publication: Laxenburg
Publisher: International Federation of Automatic Control IFAC
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Name: Power Plant and Power System Control
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