A NEW SOLUTION FOR ASYNCHRONOUS
INCREMENTAL MAINTENANCE OF MATERIALIZED
VIEWS (p. 6–13)

Nguyen Tran Quoc Vinh

The University of Da Nang – University of Science and Education,
Da Nang city, Vietnam
ORCID: http://orcid.org/0000-0003-2281-0429

Tran Trong Nhan

The University of Da Nang – University of Science and Education,
Da Nang city, Vietnam
ORCID: http://orcid.org/0000-0001-6516-6579

Le Van Khanh

The University of Da Nang – University of Science and Education,
Da Nang city, Vietnam
ORCID: http://orcid.org/0000-0002-8093-9215

Tran Dang Hung

Hanoi National University of Education, Hanoi, Vietnam
ORCID: http://orcid.org/0000-0001-7691-6486

Abeer Alsadoon

Charles Sturt University, Darlinghurst, Australia
ORCID: http://orcid.org/0000-0002-2309-3540

PW Chandana Prasad

Charles Sturt University, Darlinghurst, Australia
ORCID: http://orcid.org/0000-0002-3007-687X

Pham Duong Thu Hang

The University of Da Nang – University of Science and Education,
Da Nang city, Vietnam
ORCID: http://orcid.org/0000-0002-0813-827X

Materialized views can help improve query execution speed dramatically using full or part of stored pre-calculated query results. Incremental maintenance takes materialized views up-to-date adjusting them accordingly to the changes in related base tables. It is often more effective than a full refresh replacing materialized view tables by the new query execution result. Asynchronous maintenance, which brings the materialized views to the actual state, is not a constituent of the transaction making changes in the base tables. Most of the published works are dedicated to synchronous incremental updating of views, algorithms for which require accessing the pre-update state of base tables and cannot be applied directly to asynchronous updates which are performed on the post-update state. A few works are devoted to asynchronous maintenance of views, either restrict changes in only one of base tables or assume there is only one base table, which is impractical, either is wrong, either provides too high level and complex incremental update algorithms or can be implemented only if the database management system supports data versioning at the table and row levels. In this paper, we propose a solution for the asynchronous incremental update of views which can be implemented with any database management systems. We collect changes in base tables, access the pre-update state of base tables exploiting the condensing process and apply the pre-update incremental maintenance algorithms for asynchronous maintenance on the post-update state of base tables considering the specifics of asynchronous maintenance. It is applicable for SPJ queries with inner joins, queries with inner joins and aggregations. We also build a prototype and provide experiments on automatic generating source codes in C to collect changes in base tables and to perform the asynchronous incremental update of materialized views in PostgreSQL.

Keywords: materialized view, pre-update state, asynchronous incremental maintenance, source code synthesis, PostgreSQL.

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DEVELOPMENT OF COGNITIVE APPROACH TO THE ORGANIZATION OF BUSINESS PROCESSES IN VIRTUAL MACHINE-BUILDING ENTERPRISES WITHIN INDUSTRY 4.0 (p. 14–23)

Khudhair Abed Thamer
Al - Maaref University College, Ramadi, Anbar, Iraq
ORCID: http://orcid.org/0000-0002-1575-2294

The paper sets out an approach to improving the efficiency of business processes at virtual machine-building enterprises (VMBE), which consists in improving the existing methodological and software tools to support the life cycle of products of such enterprises within Industry 4.0. In the approach, the concept of creating, deploying and implementing business processes at VMBE and principles of this concept, as well as methods for implementing the basic principles, are considered. The essence of the approach is to organize a full production cycle at VMBE, with almost complete absence of fixed assets at such an enterprise. This involves the fixed assets of subcontractors distributed within the country and, in some cases, abroad. The peculiarity of the approach lies in taking into account the specifics of the Industry 4.0 concept, the main feature of which is the individualization of production and consumption. Practical application of the discussed approach will ensure: the formation of VMBE marketing policy by creating a multi-agent web-based environment; decision support for the adaptation of VMBE production to the current market conditions; alternative choice of subcontractors in the organization of virtual production using multi-agent technologies; information support for decisions on the feasibility of manufacturing VMBE products based on OLAP technology; adjustment of the life cycle of VMBE products by applying special information support methods and models for organizational management of VMBE. The effectiveness of the described approach is shown by analyzing the activities of a typical VMBE. The results of the study can be used to organize, deploy and support the effective functioning of virtual production enterprises in various industries.

Keywords: multi-agent web-based environment, virtual machine-building enterprises, Industry 4.0, decision support.

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A STUDY OF SELF-ORGANIZATION OF SCIENTIFIC COMMUNICATIONS: FROM STATISTICAL PATTERNS TO LAW (p. 24–29)

Leonid Kostenko
Vernadsky National Library of Ukraine, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0001-7629-1228

Tetiana Symonenko
Vernadsky National Library of Ukraine, Kyiv, Ukraine
ORCID: https://orcid.org/0000-0003-4188-8280

The article considers statistical laws of scientific communications and describes the phenomena and processes of self-organization in library science, science of science, and linguistics. Synergetics is chosen as the methodological basis of research.

The aim of the study is to develop a synergistic concept of the emergence of statistical laws of information processes and phenomena in scientific communications for their generalization and presentation in the form of a single law.

The concept of synergetics is developed for scientific communications as a manifestation of objectively existing but theoretically unsubstantiated quantitative relations between the subjects and objects of these communications (scientists, publications, and terms). The necessity of using stable distribution laws of probability theory for describing scale-invariant phenomena and processes is noted. In the mathematical sense, the stability of the distribution law is the property of preserving its type for any sum of random variables having this distribution. The mathematical abstraction of a 'random variable' in scientific communications takes on a clear concreteness. For Bradford's regularity, the random variable is the number of articles on a particular topic in the journal; for Lotka's regularity, it is the number of scholar's

publications; and for Zipf's regularity, it is the frequency of using the word in the text.

The study has determined the characteristic indicator of the stable law of the distribution of processes and phenomena in scientific communications, which is equal to the constant of the golden section.

A synergistic concept of scientific communications is formulated as follows: scale-invariant processes and phenomena of self-organization are a manifestation of a stable distribution law of probability theory with a characteristic indicator equal to the constant of the golden ratio.

Keywords: librarianship, statistical laws, large-scale invariance, stable distribution.

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Maksym Lupei
Uzhhorod National University, Uzhhorod, Ukraine
ORCID: http://orcid.org/0000-0003-3440-3919

Alexander Mitsa
Uzhhorod National University, Uzhhorod, Ukraine
ORCID: http://orcid.org/0000-0002-6958-0870

Volodymyr Repariuk
Uzhhorod National University, Uzhhorod, Ukraine
ORCID: http://orcid.org/0000-0001-7957-4688

Vasyl Sharkan
Uzhhorod National University, Uzhhorod, Ukraine
ORCID: http://orcid.org/0000-0002-9162-5756

The problem of development of an effective method for text authorship identification (on the material of publications of well-known Ukrainian journalists) is explored. Most existing methods require text preprocessing, which entails new costs when solving the set problem. In the case where the number of possible authors can be minimized, this approach is often excessive. Another disadvantage of the existing approaches is that their vast majority was applied to texts in foreign languages and did not take into consideration the peculiarities of the Ukrainian language. Therefore, it was decided to develop an approach that makes it possible to identify the author of the text in Ukrainian without preprocessing and give high accuracy results, as well as to establish what types of artificial neural networks provide the minimum error for Ukrainian publicists.

The developed method uses a multilayer perceptron of direct distribution, the algorithm of supervised learning, vectorization HashingVectorizer, and Adam optimizer. It was determined that with a small number of iterations (4–5 iterations) of artificial neural network learning, we obtain a rather high accuracy of identification of authorship of journalistic texts and rather small value of error. Over 1,000 fragments of texts by three Ukrainian authors were used. As a result of the conducted experiments, it was found that the application of the developed approach to solving the set problem enables achieving rather high results. In the texts containing not less than 500 characters, the accuracy reaches 91 %, and the maximum number of iterations of artificial neural network learning does not exceed 15. Such results were achieved primarily due to the efficient selection of the vectorization method at the preparatory stage and the structure of an artificial neural network.

Keywords: authorship identification, text analysis, artificial neural networks, multilayer perceptron, text vectorization.

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ENCODING SYRIAC LETTERS IN PARTITION THEORY USING EXTENDED VIGENERE CIPHER (p. 37–46)

Hadil H. Sami
College of Education, University of Al-Hamdaniya, Bakhdida, Hamdaniya, Iraq

Ammar S. Mahmood
College of Education for Pure Science,
University of Mosul, Mosul, Iraq
ORCID: http://orcid.org/0000-0001-8799-5503

Since the topic of e – Abacus diagram appeared in 1978 through its application within the partition theory, where this representation was one of the ideas of cryptography, many researchers study this subject from a purely theoretical perspective without practical application to it. Many researchers have shown interest in it by starting to apply purely mathematically, but starting in the past few years they have been searching for ideas that serve the topic. This research deals with the Vigenere Cipher, which is one of the multi-alphabet ciphers and in the past it was one of the most popular ciphers. For its simplicity and resistance to frequency analysis tests for messages encoded with simple ciphers such as Caesar's Cipher through. Its application to the Syriac letters, which is one of the oldest ancient languages, used exclusively when reading religious hymns, for Christians in some regions of the world and in other regions as a trading language. In 2017 it was carefully studied through the above diagram and made the application more confidential among its users in terms of trying to find a suitable agreement between the English language letters and Syriac. By extending the idea of encryption above mathematically as well as by expanding the Vigenere schedule. Special signs and symbols were used in the Syriac language to be able to address the problem of the difference in the number of letters between the two languages. As well as the possibility of using the Cipher between the letters of the Syriac language.

Keywords: partition theory, beta numbers, Vigenere cipher, Syriac letters, English letters.

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Oleksii Sheremet
Donbass State Engineering Academy, Kramatorsk, Ukraine
ORCID: http://orcid.org/0000-0003-1298-3617

Oleksandr Sadovoi
Dniprovsky State Technical University, Kamyanske, Ukraine
ORCID: http://orcid.org/0000-0001-9739-3661

The study is based on the use of the discrete time equalizer method for the synthesis and practical implementation of an automatic speed control system of a direct current electric drive. A laboratory research bench was created to carry out experimental research.

The synthesis of automatic control systems by the discrete time equalizer method differs from the traditional subordinate coordinate control or the generalized characteristic polynomial method in complete rejection of the use of the desired characteristic polynomials. This approach allows obtaining the desired dynamic and static properties of the system solely on the basis of the desired transition function, which should be close to the natural character of the transition processes (monotonic, aperiodic or oscillatory).

The Code Composer Studio integrated design environment allows practical implementation of the proposed discrete time equalizers, the inverse model of the control object, and the inverse transformation modification unit in the form of special routines for the Texas Instruments TMS320F28335 microcontroller – macros in the C/C++ programming language.

The main body of the control program, constructed in accordance with the developed functional diagram of macros interaction, made it possible to carry out the experimental studies using both the main control channel with one discrete time equalizer and the combined control with two discrete time equalizers (main and compensating). Since the entire program code used in the research was written in the high-level programming language C/C++ using object-oriented approaches, it is hardware independent of the microprocessor type and can be transferred easily to another hardware base.

Keywords: discrete time equalizer, microcontroller, automated control system, direct current motor.

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A SYSTEM OF AUTOMATED CONTROL FOR THE BAKING PROCESS THAT MINIMIZES THE PROBABILITY OF DEFECTS (p. 58–67)

Anton Korotynskyi
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0002-6309-5970

Oleksii Zhuchenko
National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, Ukraine
ORCID: http://orcid.org/0000-0001-5611-6529

We have designed and investigated a system of automated control for a carbon baking furnace that makes it possible to minimize the probability of defects. Based on the artificial neural networks, it differs from actual systems by the possibility to select the technique to control the process of baking in accordance with the starting conditions and the purpose of the process.

Such purposes in the process for baking carbon articles include the obtaining of products with a minimum number of defective structures or a safe reduction in the length of the technological process to save energy.

To minimize the number of defective structures in finished products, it is proposed to predict the probability of a defect in a product and, to reduce the duration of the technological process, to apply entropy as an indicator of product readiness. Solving the set tasks is based on the use of artificial neural networks with their capability to generalize data, namely different values of the probability of a defect in the various temperature fields in a baking furnace under operational modes.

The issue of the limited amount of data required to train an artificial neural network is resolved by applying a special structure of artificial neural networks, an autoencoder.

The designed control system has several advantages over the systems already in use. For example, it makes it possible to select a step of the descent that determines the accuracy of the optimal descent trajectory and, therefore, the accuracy of control in general. Selecting a descent criterion makes the designed system flexible when used under different conditions and for different control tasks. In case of an emergency interruption of the technological process of baking, a given system makes it possible to plan its further progress at any time, thereby providing for an effective continuation of the baking process and thus avoiding unjustified expenditures. The control algorithm used in the system makes it possible to predict the duration of baking and the value of fuel consumption and thus predict the economic efficiency of the technological process.

To assess the efficiency of the proposed system of automated control over the baking process, we have performed an experimental study of the designed system operation compared to the actual control system based on a PID-controller.

The study results have demonstrated that the use of the new control system makes it possible to reduce fuel consumption by 3–4 m^3/h. In addition, there is a decrease in the growth of the temperature of blanks during treatment, which positively affects the quality of the finished products.

Keywords: baking process, artificial neural networks, autoencoder, predictive control system, simulation.

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EXPERIMENTAL SET-UP DESIGN OF SOFC SINGLE CELL PERFORMANCE USING SIMPLE FURNACE WITH MAXIMUM TEMPERATURE OF 1000 DEGREES (p. 68–76)

Darjat
Diponegoro University, Semarang, Indonesia
ORCID: http://orcid.org/0000-0003-4515-3302

Sulistyo
Diponegoro University, Semarang, Indonesia
ORCID: http://orcid.org/0000-0002-3232-7871

Aris Triwiyatno
Diponegoro University, Semarang, Indonesia
ORCID: http://orcid.org/0000-0001-8666-2678

Sumardi
Diponegoro University, Semarang, Indonesia
ORCID: http://orcid.org/0000-0002-5596-6093

Isroni Widiyantoro
Diponegoro University, Semarang, Indonesia
ORCID: http://orcid.org/0000-0002-0226-3846

Real-time monitoring and control of solid oxide fuel cell (SOFC) systems are important to identify and understand cell performance. Some parameters that affect the performance of SOFC cells include fuel flow rate, furnace temperature, and the cell material itself. These parameters have a correlation with each other in making SOFC cells to be applied as a substitute for alternative energy. This results in a reliable SOFC cell, optimal output voltage and lower operating temperature. Because so far the material of SOFC cells is ceramics that have a working temperature range between 500–1000 °C. Monitoring is limited by the SOFC operating environment around the furnace. SOFC operations are limited to hydrogen and oxygen fuel flow channels. The maximum furnace operating temperature is 1000 degrees, and the minimum output voltage for one cell. Therefore, it is necessary to place sensor sensing points as needed. This study aims to design a monitoring and regulation system for hydrogen/oxygen flow in the SOFC operating environment based on the Arduino Mega 2560 microcontroller and computer interface. Valve control uses open-loop and on-off control methods. Open-loop control is used to set the valve rotation angle value. While the on-off control to close the valve automatically when there is an excess concentration of hydrogen in a laboratory room. The system is designed for the needs of laboratory-scale experiments on simple furnaces. This device also functions as a simple mini prototype module. So that it can be used as material to learn and understand the SOFC system widely. The prototype test results show that the flow of hydrogen can be adjusted from 0.07–4.74 L/min and oxygen can be adjusted between 0.24–4.8 L/min. Temperature sensors have an average error of 2.6 % and voltage sensors have an accuracy of 0.1 V.

Keywords: SOFC, hydrogen, oxygen, performance, cell, sensor, flow, arduino, voltage, furnace.

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DETERMINING WEIGHT COEFFICIENTS FOR AN OPTIMAL SYSTEM OF CONTROL OVER ELECTRIC ENERGY GENERATION IN A COMBINED ELECTRIC POWER SYSTEM (p. 77–82)

Petro Plieshkov
Central Ukrainian National Technical University,
Kropyvnytskyi, Ukraine
ORCID: http://orcid.org/0000-0003-2141-4811

Valentyn Soldatenko
Central Ukrainian National Technical University,
Kropyvnytskyi, Ukraine
ORCID: http://orcid.org/0000-0002-7781-9343

Vasyl Zinzura
Central Ukrainian National Technical University,
Kropyvnytskyi, Ukraine
ORCID: http://orcid.org/0000-0001-6357-064X

Serhii Plieshkov
Central Ukrainian National Technical University,
Kropyvnytskyi, Ukraine
ORCID: http://orcid.org/0000-0002-3120-5397

This paper reports a solution to a relevant scientific task of determining the weight coefficients for an optimal system of automated control over the level of electric energy generation by renewable energy sources in a combined electric power system. It has been established that existing control systems of electric power generation by renewable sources, based on solving a problem on multicriteria optimization, do not take into consideration a change in the quantitative and qualitative composition of electric consumers over time.

It has been proposed, in order to determine those weight coefficients that influence the resulting solution to the problem on multicriterial optimization, to employ a mathematical apparatus of fuzzy logic. This has made it possible, in contrast to existing systems, to better account for a time-dependent change in the quantitative and qualitative composition of electricity consumers. It has been shown that it is expedient to choose, as the input parameters for a fuzzy model, the values for a coefficient of consumer load and a coefficient of load importance that takes into consideration the sensitivity of electric consumers to voltage deviations.

A database of rules for a fuzzy system of weight coefficients determination has been constructed, which includes 15 rules of fuzzy production. The Mamdani algorithm has been used as an algorithm of fuzzy logic derivation. To determine the input and output linguistic variables we have used triangular and trapezoidal membership functions. The output parameter was defuzzified by the method of determining the center of gravity (centroid method).

We have performed computer simulation of the optimal system of an automated system of control over the level of electric energy generation by renewable energy sources using the designed fuzzy unit for determining weight coefficients. Analysis of the simulation results has shown that the devised system of automated control makes it possible to increase the level of electricity generation to a network, as compared to existing systems.

Keywords: automated control system, renewable energy sources, electrical distribution network, fuzzy logic.

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