

CONTENTS AND ABSTRACTS

RADIO ENGINEERING AND RADAR

B. A. ATAJANTS, V. M. DAVYDOCHKIN, V. V. EZERSKIY. LEVEL MEASUREMENT ERROR BY FREQUENCY-MODULATED LEVEL GAUGE WITH IRREGULAR WAVE GUIDE

Keywords: frequency-modulated level gauge, irregular waveguide, unevenness of characteristics, level measurement error, individual calibration parameters, error reduction.

The problem of measuring the level of filling the tank with liquid substance by means of waveguide frequency-modulated level gauge is considered. The level estimation error is considered to be caused by dispersion of electromagnetic waves in a waveguide and is easily eliminated by introducing the predistortions to the law of frequency modulation. Additional error arises when using an irregular waveguide. The irregularity is caused by the need to use a compound waveguide when heterogeneity of properties of the pieces used is observed. The aim of the work is to estimate possible measurement error caused by piecewise heterogeneity of a waveguide and to develop a method allowing us to make this error significantly lower. Error estimation caused by waveguide irregularity at practical realization of a waveguide level gauge is made. The method of reducing the error by using individual calibration parameters for each site of quasiuniformity is offered. The technique of practical determination of individual parameters is offered. Quantitative assessment of reached effect is carried out.

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B. V. KOSTROV, A. A. KONKIN. DEVELOPMENT OF METHODOLOGY TO CALCULATE ATTENUATION RADIO SIGNAL INTRODUCED BY DIFFERENT TYPES OF OBSTACLES

Keywords: shield, shielded structure, shielding efficiency, radio signal, radio signal attenuation.

Shielded structures are widely used today to perform various tasks ranging from providing EMC equipment and ending with the protection of information processed by the technical means located in such a shielded structure. At the same time, when a shielded structure performs the function of protecting information, it is important to understand how significant the influence on the signal propagation to the location of the alleged intruder is made not only by the shielded structure used, but also by other obstacles located on signal propagation path. The aim of the work is to develop a methodology for estimating the attenuation of the radio signal introduced by various obstacles, which are various previously known materials with known characteristics. The dependence of the effectiveness of screening, absorption and internal multiple reflection of electromagnetic waves on the type and characteristics of both conductors and dielectrics is considered.

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A. A. TIPIKIN. GENERALIZED METHOD TO CALCULATE FIELD STRENGTH OF GROUND WAVE IN VERY LOW FREQUENCY BAND FOR A PATH WITH ARBITRARY NUMBER OF HOMOGENEOUS SEGMENTS

Keywords: electric field strength, earth wave, underlying surface, forecasting, very low frequencies.

The shortcomings of existing methods for calculating the ground wave field strength are determining the relevance of the study. Despite the detailed theoretical study in this area, known software implementations of the techniques do not allow taking into account an arbitrary number of sections with specified characteristics of underlying surface on a ground wave propagation path. The aim of the research is to generalize well-known theoretical studies on predicting the ground wave field strength and to develop an applied automated technique that allows calculations on the routes with an arbitrary number of homogeneous sections with data input from corresponding digital maps. This technique is implemented in the form of a script and a set of auxiliary functions in MatLab environment. The example of calculations for a path consisting of six segments is presented.

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**INTELLIGENT INFORMATION SYSTEMS
AND TECHNOLOGIES****I. YU. KASHIRIN. NEURAL NETWORKS OF NEW MULTIPOLAR WORLD: CLASSIFICATION OF ELECTRONIC NEWS**

Keywords: neural Bert networks, natural language analysis, identification of news content, transformer architecture, text corpus assembly, pre-trained models.

A new technology for automatic identification of news media materials is being considered, dividing them into pro-Western content and the articles from independent states. Domestic publishers are used as content sources: RT, Meduza, Kremlin, Globalaffairs, Themoscwotimes, RussiaBeyond, Rossiyasegodnya, Interfax, SputnikInternational and others. Western information publications are represented in the study by publishers: msnbc, bloomberg, cnn, springer, nbcnew, thrguardian, Facebook, nytimes, france24 and others. The theoretical foundations used in the study are based on the concept of neural networks with concentration of attention, namely a bidirectional model with Bert transformer architecture.

The experimental part of the material uses software oriented to Python v.3 (Anaconda 3). The software implementation of text corpus collection, subsequent content processing and neural network analysis involves the use of nltk, transformers 4.34.1, BeautifulSoup, wordcloud, BertForSequenceClassification, torch 3.12.4, newspaper, json, tensorflow 2.14.0, accelerate 0.20.1, sklearn. In addition to the listed software, the research uses the htmlgrabber v.2.0 package developed by the author. The performed series of experiments allows us to qualify the presented technology as an electronic news identification technology, which is not inferior in efficiency to the international analogues available today.

The aim of the work is to create a new neural network technology used in the automated identification of information content in natural language to classify electronic news into Western and independent.

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YU. L. LEOKHIN, T. D. FATKHULIN, M. S. KOZHANOV. ANALYSIS AND RESEARCH OF NEURAL NETWORK TECHNIQUES APPLICATION FOR PROGRAM CODE GENERATION

Keywords: neural network techniques, programming, automation, artificial intelligence, program code, advantages, disadvantages, optimization, development.

The problem of studying the influence of a user-composed prompt on the efficiency of the generated program code is considered. The aim of the work is to develop a methodology that makes it possible to analyze the operation of online neural network services that generate program code and evaluate their effectiveness. The relevance of the work is due to the widespread introduction of neural network techniques in all spheres of human life, including software development. The online neural network services «ChatGPT 3.5», «ChatGPT 4», «YandexGPT 2» and «GigaChat» are considered, which allow generating program code in a specific programming language in question-and-answer form. A methodology is given for determining the effectiveness of neural network tools used to generate program code. The developed methodology is tested by introducing multi-level tasks into neural network services under consideration and analyzing the program code generated by them. In conclusion, the results of the analysis of data obtained during the experiments are presented and conclusions are drawn.

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A. V. KRIVOSHEEV. INTEGRATION OF MULTI-AGENT AND NEURAL NETWORK TECHNOLOGIES IN A PATTERN RECOGNITION SOFTWARE SYSTEM FOR ROBOTIC DOCUMENT FLOW

Keywords: pattern recognition, text processing, software system architecture, artificial intelligence technologies, machine learning, multi-agent technologies, ensemble.

The problem of integrated application of software development technologies with the elements of artificial intelligence to expand the possibilities of their use as part of modern robotic document flow systems is considered. A method of multi-agent ensemble of intelligent components of an adaptive pattern recognition system is proposed, which consists of encapsulating artificial neural networks through software agents, united through links and connections into a virtual world architecture that most rationally ensures their interaction with each other to implement automatic dispatch and competition strategies. Testing of the method and architecture proposed was also carried out in the implementation of intelligent system for text comprehension and text generation for the joint use of several artificial neural networks with different training data sets for a comprehensive solution to various problems of semantic analysis of texts in Russian. The use of ensemble of intelligent components within the framework of dynamic dispatch makes it possible to increase the performance of pattern recognition software as part of a document management system by 2.5 times compared to classical methods of combining neural networks.

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K. A. GULYAEVA, I. L. ARTEMIEVA. TOOLKITS FOR CONCEPT SYSTEM AND KNOWLEDGE BASE DESIGN FOR APPLICATION DOMAINS WITH COMPLEX-STRUCTURED OBJECTS

Keywords: knowledge base, intelligent system, ontology, application domain, complex-structured system, applied logics theory, intermediary concepts, reaction capacity identification.

Concept systems and knowledge bases for application domains with complex-structured objects are expanded rapidly. Time-consuming operations for knowledge base design, which includes choosing its scheme, savvy selection of interim concepts, designating its filling type are performed by application domain experts. The question is whether it is possible to automate this process. Can we suggest any specialized expert decision support toolkits? The aim is to develop and research specialized program toolkits for structuring applied concept systems and knowledge bases grounded on them for application domains with complex-structured objects (based on a chemical compound reaction capacity identification problem). This research suggests that the hybrid editor be used, which works in two automation regimes. It allows any application domain expert to choose – to make minimum effort or to customize the process of concept system and knowledge base development, whichever is preferable. Basic elements of hybrid editor are complex-structured system metagraph editor, metaconcept generator, and function and predicate constructor. Complex-structured system is created with the help of metagraph editor. The subsystems of complex-structured system can be of four structural types: elementary system, descriptive system, system-subset, and system-process. Metaconcept generator automatically forms the set of metaconcepts that match with interim concepts. Function and predicate signatures are set by an application domain expert with the help of function and predicate constructor with arbitrary argument list and function and predicate metaconcept constructor. The latter automatically sets some of the allowable arguments, which facilitates application domain expert work during concept system and knowledge base formation.

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MATHEMATICAL AND COMPUTER MODELING**S. V. SKVORTSOV, V. I. KHRYUKIN, T. S. SKVORTSOVA. ANALYTICAL AND GRAPHICAL MODELING OF CONTROL SYSTEMS BASED ON PID CONTROLLERS**

Keywords: technical object control, PID controller synthesis, analytical and graphical model, frequency transfer function, logarithmic amplitude-frequency response.

An analytical model of a control system based on PID controller is considered, for which the limited application associated with the inability to meet all requirements for system quality is shown. To eliminate these disadvantages, the authors propose to additionally use a graphical model based on desired logarithmic amplitude-frequency response of the system. The aim of the work is to develop an analytical and graphical model that allows combining the advantages of formalized and non-formalized approaches to the design of modern control systems for technical objects. A technique for parametric synthesis of PID controller, based on this model, has been developed that provides specified requirements for the system in terms of accuracy, speed and quality of transients. The application of the proposed technique is shown on the example of synthesizing a control system for an unstable technical object. The simulation results in

Matlab/Simulink environment confirm the possibility of practical implementation of such a control system that provides the specified requirements.

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D. A. PEREPEL'KIN, V. Y. LIKUCHOV. DEVELOPMENT OF ALGORITHMS FOR STRUCTURING ELECTRICAL CIRCUITS IN SOLVING THE PLACEMENT PROBLEMS OF ELECTRONIC COMPONENTS BASED ON MULTI-AGENT SYSTEMS

Keywords: design automation, topological design, component placement, multi-agent system, electronic module, printed circuit board.

With the development of the radio-electronic industry, the nature and specifics of the design procedures of specialized radio-electronic devices are changing. The following factors continuously influence this process: firstly, the tightening of requirements for the quality and accuracy of device operation, and secondly, the miniaturization of electronic components and consequently, an increase in the dimensionality of the circuits assembled on first-level modules. The use of automated design tools helps to shorten product development times; however, under the conditions described above, it is necessary for these tools to solve the problem taking into account a multitude of criteria, and the design result must satisfy the multitude of requirements posed to the structure, which is especially difficult with large circuit dimensions.

At the core of automated design tools lie mathematical and algorithmic apparatuses based on a certain model of object representation. An effective way to improve design tools is to represent the object as a system, that is, a collection of interconnected elements (agents), which in turn can form larger structural elements. For example, in the task of placing ECs on a printed circuit board, depending on the level and criterion of representation, the elements of the structure are the ECs themselves, functional nodes, symmetrical groups of ECs, and groups of ECs with specific properties. Particular attention is required for the development of structuring algorithms, that is, the identification of structural elements. The criteria for identification should be such that each element corresponds to a functional or structural part of the object of design. Only such a solution will allow for considering the full range of requirements for the design under development. Moreover, the correct choice of identification criteria will optimize the computational process of placement, eliminate unnecessary iterations, and parallelize typical operations due to the repetition of structural elements identified during the structuring stage.

The aim of this work is to describe methods and algorithms for structuring electrical circuits to solve the problem of placing electronic components based on multi-agent systems.

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SYSTEM ANALYSIS, MANAGEMENT AND INFORMATION PROCESSING

N. A. EGOSHKIN, V. A. EREMEEV, A. A. MAKARENKO. HYPERSPECTRAL EARTH IMAGING SIGNAL TRANSMISSION CHAIN MODEL AND ITS APPLICATIONS

Keywords: Earth remote sensing data, hyperspectral imaging, signal transmission chain, spectral reflectance co-efficient, spectral characteristic, signal transmission through atmosphere.

Strict and approximate definitions of the parts of signal transmission chain of aerospace hyperspectral Earth remote sensing imaging are described in the article. A piecewise

linear model of data transformation in spatial-frequency domain during the formation of hyperspectral images is presented and examined. Approaches for using neural network technologies to counter uncertainties when using purely analytical models are considered. The results of experiments confirming proposed approaches are presented.

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A. I. NOVIKOV, A. G. AGAFONOV. ANALYSIS AND FORECASTING OF NONSTATIONARY TIME SERIES WITH A SEASONAL COMPONENT

Keywords: time series, trend, cyclic component, seasonality, forecasting, discrete Fourier transform, amplitude spectrum.

The aim of the work is to develop methods for analyzing and predicting time series that are an additive mixture of low-frequency (trend), cyclic and random components. A feature of cyclic, in particular, seasonal component in the examples under consideration is the change in its amplitude during the transition from one time interval corresponding to the oscillation period to the next period. Several approaches to the study of such series are considered. A traditional approach is when a trend, a cyclical component and the remainder of the series are sequentially highlighted. The modification consists in the fact that in order to account for changes in the amplitude of cyclic component, a description of the coefficients in the model of harmonic component for sine and cosine functions in the form of linear functions of time is proposed. In the second case, all the parameters of the model describing such a series are found together using the least squares method (LSM). This makes it possible to increase the accuracy of both the approximation of the series and its forecast. To improve the accuracy of time series forecast, in the dynamics of which local features appear that are not taken into account by a mathematical model of the series, the authors propose the difference between the values of the original series and the estimates to be included in a forecast model according to the model used for the time period preceding a forecast period and coinciding with it in length.

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INFORMATION-MEASUREMENT AND BIOMEDICAL SYSTEMS

V. P. KORYACHKO, S. S. RUMYANCEV, L. V. ARONOV. MEASURING WATER TEMPERATURE BY PULSE REFLECTOMETRY METHOD IN PRIMARY LOOP OF NUCLEAR POWER PLANT

Keywords: reflectometric level gauge, pulsed reflectometer, mathematical model, nuclear power plant, computer model, temperature measurement.

This article proposes a method for indirect measuring water temperature, based on the sensitive element of pulse reflectometric level meter, in primary circuit tanks of a nuclear power plant in the temperature range of 275...625K with pressure fluctuations in the range of 0.1-25MPa. A calibration curve of temperature was obtained based on averaging and approximation by a polynomial of the second degree of the results of experimental measurements with root-mean-square error of 1.35 %, while the relative error of temperature measurement by the proposed method is at least 3.95 %. An expression is derived to determine the resulting relative measurement error and recommendations for its reduction.

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S. A. NOVIKOV, M. B. NIKIFOROV, O. V. MELNIK. STUDY OF ELECTROMAGNETIC METHOD FOR TRACKING TREMOR OF HUMAN UPPER LIMB BASED ON THEREMEN-VOX SCHEME

Keywords: tremor, intoxication, pre-trip, analysis, postural, driver.

The article discusses an electromagnetic method for tracking postural tremor within the framework of the task of pre-trip driver analysis. The resolution of the method was studied, and the optimal working area in which it is necessary to measure tremor parameters was found. The performance of the method, as well as the circuit solution, was determined.

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PHYSICAL ELECTRONICS

S. A. KRUGLOV, A. A. SEREZHIN, D. S. KUSAKIN. CONSTRUCTION OF HIGH-VOLTAGE POWER SYSTEMS BASED ON INDUCTIVE ENERGY STORAGE AND GAS-DISCHARGE CURRENT INTERRUPTER

Keywords: high-voltage pulse generator, inductive energy storage, gas-discharge current interrupter, output capacitor charging time, current interruption time, high-voltage system.

The problem of constructing power systems based on high-voltage pulse generator with inductive energy storage device that can be used as control and testing systems for high-voltage equipment is considered. The aim of the work is to build a new type of high-voltage pulsed voltage generators using a combined type of energy storage. Two methods of constructing high-voltage systems are considered (with high-voltage electronic valve connected to load capacitor, and using pulse transformer). Based on the results of computer modeling, the operating ranges of values for the main elements of the circuits have been determined.

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