

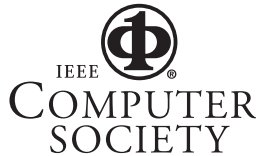
KHARKOV NATIONAL UNIVERSITY OF RADIOELECTRONICS

Proceedings of IEEE East-West Design & Test Symposium (EWDTS'09)

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IEEE Computer Society Test Technology Technical Council



Moscow, Russia, September 18 – 21, 2009

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7th IEEE EAST-WEST DESIGN & TEST SYMPOSIUM (EWDTS 2009)

Moscow, Russia, September 18-21, 2009

The main target of the **IEEE East-West Design & Test Symposium** (EWDTS) is to exchange experiences between scientists and technologies of Eastern and Western Europe, as well as North America and other parts of the world, in the field of design, design automation and test of electronic circuits and systems. The symposium is typically held in countries around the Black Sea, the Baltic Sea and Central Asia region. We cordially invite you to participate and submit your contribution(s) to EWDTS'09 which covers (but is not limited to) the following topics:

- Analog, Mixed-Signal and RF Test
- Analysis and Optimization
- ATPG and High-Level Test
- Built-In Self Test
- Debug and Diagnosis
- Defect/Fault Tolerance and Reliability
- Design for Testability
- Design Verification and Validation
- EDA Tools for Design and Test
- Embedded Software Performance
- Failure Analysis, Defect and Fault
- FPGA Test
- HDL in test and test languages
- High-level Synthesis
- High-Performance Networks and Systems on a Chip
- Low-power Design
- Memory and Processor Test
- Modeling & Fault Simulation
- Network-on-Chip Design & Test
- Modeling and Synthesis of Embedded Systems
- Object-Oriented System Specification and Design
- On-Line Testing
- Power Issues in Design & Test
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- Reliability of Digital Systems
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- Place and Route
- Thermal, Timing and Electrostatic Analysis of SoCs and Systems on Board
- Wireless and RFID Systems Synthesis
- Digital Satellite Television
- Signal and Information Processing in RF and Communication

The symposium is organized by Kharkov National University of Radio Electronics, in cooperation with Tallinn University of Technology, Institute for System Programming of RAS, and Moscow Institute of Electronics and Mathematics. It is sponsored by the IEEE Computer Society Test Technology Technical Council (TTTC) and financially supported by Cadence, JTAG Technologies, Kaspersky Lab, Synopsys, Mentor Graphics, Tallinn Technical University, Donetsk Institute of Road Transport, Moscow Institute of Electronics and Mathematics, Virage Logic, Echostar, Aldec, Teprocomp, DataArt Lab.



CONTENTS

Simulation-based Verification with APRICOT Framework using High-Level Decision Diagrams Maksim Jenihhin, Jaan Raik, Anton Chepurov, Raimund Ubar	13
Fault-Detection Capability Analysis of a Hardware-Scheduler IP-Core in Electromagnetic Interference Environment J. Tarrillo, L. Bolzani, F. Vargas, E. Gatti, F. Hernandez, L. Fraigi	17
Hardware Reduction in FPGA-Based Compositional Microprogram Control Units Barkalov A.A., Titarenko L.A., Miroshkin A.N.	21
Optimization of Control Units with Code Sharing Alexander A. Barkalov, Larisa A. Titarenko, Alexander S. Lavrik	27
SAT-Based Group Method for Verification of Logical Descriptions with Functional Indeterminacy Liudmila Cheremisinova, Dmitry Novikov	31
MicroTESK: Automation of Test Program Generation for Microprocessors Alexander Kamkin	35
Verification Methodology Based on Algorithmic State Machines and Cycle-Accurate Contract Specifications Sergey Frenkel and Alexander Kamkin	39
Coverage Method for FPGA Fault Logic Blocks by Spares Vladimir Hahanov, Eugenia Litvinova, Wajeb Gharibi, Olesya Guz	43
Testing and Verification of HDL-models for SoC components Vladimir Hahanov, Irina Hahanova, Ngene Christopher Umerah, Tiecoura Yves	48
The Model of Selecting Optimal Test Strategy and Conditions of ICs Testing During Manufacturing Sergey G. Mosin	54
A Technique to Accelerate the Vector Fitting Algorithm for Interconnect Simulation Gourary M.M., Rusakov S.G., Ulyanov S.L., Zharov M.M.	59
Frequency Domain Techniques for Simulation of Oscillators Gourary M.M., Rusakov S.G., Stempkovsky A.L., Ulyanov S.L., Zharov M.M.	63
Distributed RLC Interconnect: Estimation of Cross-coupling Effects H.J. Kadim, L.M. Coulibaly	67
Constrained-Random Verification for Synthesis: Tools and Results D. Bodean, G. Bodean, O. Ghincul	71
Discussion on Supervisory Control by Solving Automata Equation Victor Bushkov, Nina Yevtushenko, Tiziano Villa	77
Generalized Faulty Block Model for Automatic Test Pattern Generation F. Podyablonsky, N. Kascheev	80
Self Calibration Technique of Capacitor's Mismatching For 1.5 Bit Stage Pipeline ADC Vazgen Melikyan, Harutyun Stepanyan	84
Applied Library of Adaptive Lattice Filters for Nonstationary Signal Processing Victor I. Djigan	87
On-chip Measurements of Standard-Cell Propagation Delay S.O. Churayev, B.T. Matkarimov, T.T. Paltashev	93
FPGA FFT Implementation S.O. Churayev, B.T. Matkarimov	96

Reconfiguration and Hardware Agents in Testing and Repair of Distributed Systems G. Moiş, I.Ştefan, Sz. Enyedi, L. Miclea	99
Symmetrization in Digital Circuit Optimization Natalia Eliseeva, Jie-Hong R. Jiang, Natalia Kushik, Nina Yevtushenko	103
Embedded Processor Power Reduction via Power aware Custom Instruction Selection Hoda Ahmadinejad, Saeed Safari, and Hamid Noori	107
Level Quantization Effects in Digital Signal Processing by Discrete Fourier Transform Method Gamlet S. Khanyan	111
A New Paradigm in Design of IIR Digital Filters Vladislav A. Lesnikov, Alexander V. Chastikov, Tatiana V. Naumovich, Sergey V. Armishev	115
Evolutionary Approach to Test Generation of Sequential Digital Circuits with Multiple Observation Time Strategy Yu. A. Skobtsov, V. Yu. Skobtsov	119
SMT-based Test Program Generation for Cache-memory Testing Evgeni Kornikhin	124
Critical Path Test Generation in Asynchronous QDI Circuits Fahime Khoramnejad, Hossein Pedram	128
Model-driven & Component-based Development Method of Multi-core Parallel Simulation Models Nianle Su, Wenguang Yu, Hongtao Hou, Qun Li and Weiping Wang	135
Minimizing of Number of Discrete Device's Controllable Points Dmitriy Speranskiy, Ekaterina Ukolova	142
VHPI-compatible Simulation and Test Generation System Dmitriy Speranskiy, Ivan Ukolov	147
Fault Tolerant HASH function with Single Element Correction and Minimum Delay Overhead Costas A. Argyrides, Carlos A. Lisboa, Dhiraj K. Pradhan, Luigi Carro	151
Analysis of the Control Vector Optimal Structure for a Minimal-Time Circuit Optimization Process A.M. Zemliak, M.A. Torres, T.M. Markina	156
Parallel Simulation of Boolean Functions by Means of GPU Włodzimierz Bielecki, Alexander Chemeris, Svetlana Reznikova	162
Two-Criterial DSSS Synchronization Method Efficiency Research Kharchenko H.V., Tklich I.O., Vdovychenko Y.I.	165
An Efficient March Test for Detection of All Two-Operation Dynamic Faults from Subclass S_{av} Gurgen Harutyunyan, Hamazasp Avetisyan, Valery Vardanian, Y. Zorian	175
Large and Very Large-scale Placement Bazylevych R.P., Bazylevych L.V., Shcherb'yuk I.F.	179
An Educative Brain-Computer Interface Kirill Sorudeykin	183
Time-Hardware Resource: A Criterion of Efficiency of Digital Signal Search and Detection Devices Alexander Fridman	187
A New Principle of Dynamic Range Expansion by Analog-to-Digital Converting Elina A. Biberdorf, Stanislav S. Gritsutenko, Konstantin A. Firsanov	193
FREP: A Soft Error Resilient Pipelined RISC Architecture Viney Kumar, Rahul Raj Choudhary, Virendra Singh	196

System Remote Control of the Robotized Complex - Pegas Dmitry Bagayev, Evsyakov Artem	200
Use of Predicate Categories for Modelling of Operation of the Semantic Analyzer of the Linguistic Processor Nina Khairova, Natalia Sharonova	204
Methodological Aspects of Mathematical Modelling of Processes in a Corporate Ecological System Kozulia T.V., Sharonova N.V.	208
Getting Optimal Load Distribution Using Transport-Problem-Based Algorithm Yuri Ladyzhensky, Viatcheslav Kourkchi	212
Dialogue-based Optimizing Parallelizing Tool and C2HDL Converter Steinberg B., Abramov A., Alymova E., Baglij A., Guda S., Demin S., Dubrov D., Ivchenko A., Kravchenko E., Makoshenko D., Molotnikov Z., Morilev R., Nis Z., Petrenko V., Povazhniy A., Poluyan S., Skiba I., Suhoverkhov S., Shapovalov V., Steinberg O., Steinberg R.	216
The System for Automated Program Testing Steinberg B., Alimova E., Baglij A., Morilev R., Nis Z., Petrenko V., Steinberg R.	218
Development of the University Computing Network for Integrated Circuit Design Atkin E., Volkov Yu., Garmash A., Klyuev A., Semenov D., Shumikhin V.	221
Increase in Reliability of On-Line Testing Methods Using Natural Time Redundancy Drozd A., Antoshchuk S., Martinuk A., Drozd J.	223
An Algorithm of Carrier Recovery for Modem with M-ary Alphabets APK-Signals without PLL Victor V. Panteleev	230
At Most Attainable of Lengths a Symmetrical Digital Subscriber Line on xDSL-technologies: Engineering-Maintenance Methods of the Calculation Victor V. Panteleev, Nikolay I. Tarasov	234
New Approach to ADC Design Stanislav S. Gritsutenko	240
Simulation of Radiation Effects in SOI CMOS Circuits with BSIMSOI-RAD Macromodel K.O. Petrosjanc, I.A. Kharitonov, E.V. Orekhov, L.M. Sambursky, A.P. Yatmanov	243
Thermal Design System for Chip- and Board-level Electronic Components K.O. Petrosjanc, I.A. Kharitonov, N.I. Ryabov, P.A. Kozyanko	247
TCAD Modeling of Total Dose and Single Event Upsets in SOI CMOS MOSFETs K.O. Petrosjanc, I.A. Kharitonov, E.V. Orekhov, A.P. Yatmanov	251
Reduction in the number of PAL Macrocells for Moore FSM implemented with CPLD A. Barkalov, L. Titarenko, S. Chmielewski	255
Schematic Protection Method from Influence of Total Ionization Dose Effects on Threshold Voltage of MOS Transistors Vazgen Melikyan, Aristakes Hovsepyan, Tigran Harutyunyan	260
5V Tolerant Power clamps for Mixed-Voltage IC's in 65nm 2.5V Salicided CMOS Technology Vazgen Melikyan, Karen Sahakyan, Armen Nazaryan	263
Analysis and Optimization of Task Scheduling Algorithms for Computational Grids Morev N. V.	267
A Low Power and Cost Oriented Synthesis of the Common Model of Finite State Machine Adam Klimowicz, Tomasz Grzes, Valeri Soloviev	270

Comparison of Survivability & Fault Tolerance of Different MIP Standards Ayesha Zaman, M.L. Palash, Tanvir Atahary, Shahida Rafique	275
Hardware Description Language Based on Message Passing and Implicit Pipelining Dmitri Boulytchev, Oleg Medvedev	279
V-Transform: An Enhanced Polynomial Coefficient Based DC Test for Non-Linear Analog Circuits Suraj Sindia, Virendra Singh, Vishwani Agrawal	283
GA-Based Test Generation for Digitally-Assisted Adaptive Equalizers in High-Speed Serial Links Mohamed Abbas, Kwang-Ting (Tim) Cheng, Yasuo Furukawa, Satoshi Komatsu, Kunihiro Asada	287
Between Standard Cells and Transistors: Layout Templates for Regular Fabrics Mikhail Talalay, Konstantin Trushin, Oleg Venger	293
On-Chip Optical Interconnect: Analytical Modelling for Testing Interconnect Performance H J Kadim	300
The Problem of Trojan Inclusions in Software and Hardware Alexander Adamov, Alexander Saprykin	304
Design methods for modulo $2n+1$ multiply-add units C. Efstathiou, I. Voyiatzis, M. Prentakis	307
Geometrical Modeling and Discretization of Complex Solids on the Basis of R-functions Gomenyuk S.I., Choporov S.V., Lisnyak A.O.	313
Selective Hardening: an Enabler for Nanoelectronics Ilia Polian and John P. Hayes	316
Parameterized IP Infrastructures for Fault-Tolerant FPGA-Based Systems: Development, Assessment, Case-Study Kulanov Vitaliy, Kharchenko Vyacheslav, Perepelitsyn Artem	322
Generating Test Patterns for Sequential Circuits Using Random Patterns by PLI Functions M. H. Haghbayan, A. Yazdanpanah, S. Karamati, R. Saeedi, Z. Navabi	326
A New Online BIST Method for NoC Interconnects Elnaz Koopahi, Zainalabedin Navabi	332
Low Cost Error Tolerant Motion Estimation for H.264/AVC Standard M. H. Sargolzaie, M. Semsarzadeh, M. R. Hashemi, Z. Navabi	335
Method of Diagnosing FPGA with Use of Geometrical Images Epifanov A.S.	340
Performance Analysis of Asynchronous MIN with Variable Packets Length and Arbitrary Number of Hot-Spots Vyacheslav Evgrafov	344
System in Package. Diagnosis and Embedded Repair Vladimir Hahanov, Aleksey Sushanov, Yulia Stepanova, Alexander Gorobets	348
Technology for Faulty Blocks Coverage by Spares Hahanov Vladimir, Chumachenko Svetlana, Litvinova Eugenia, Zakharchenko Oleg, Kulbakova Natalka	353
The Unicast Feedback Models for Real-Time Control Protocol Babich A.V., Murad Ali Abbas	360
Algebra-Logical Repair Method for FPGA Logic Blocks Vladimir Hahanov, Sergey Galagan, Vitaliy Olchovoy, Aleksey Priymak	364

The Method of Fault Backtracing for HDL - Model Errors Searching Yevgeniya Syrevitch, Andrey Karasyov, Dariya Kucherenko	369
Handling Control Signals for the Scan Technology Olga Lukashenko, Dmitry Melnik, Vladimir Obrizan	373
Robust Audio Watermarking for Identification and Monitoring of Radiotelephone Transmissions in the Maritime Communication Vitaliy M. Koshevyy, Aleksandr V. Shishkin	377
An Interconnect BIST for Crosstalk Faults based on a Ring LFSR Tomasz Garbolino, Krzysztof Gucwa, Andrzej Hławiczka, Michał Kopeć	381
Generation of Minimal Leakage Input Vectors with Constrained NBTI Degradation Pramod Subramanyan, Ram Rakesh Jangir, Jaynarayan Tudu, Erik Larsson, Virendra Singh	385
Very Large-Scale Intractable Combinatorial Design Automation Problems – Clustering Approach for High Quality Solutions Roman Bazylevych and Lubov Bazylevych	389
Flexible and Topological Routing Roman Bazylevych and Lubov Bazylevych	390
An Algorithm for Testing Run-Length Constrained Channel Sequences Oleg Kurmaev	391
Constructing Test Sequences for Hardware Designs with Parallel Starting Operations Using Implicit FSM Models Mikhail Chupilko	393
Redundant Multi-Level One-Hot Residue Number System Based Error Correction Codes Somayyeh Jafarali Jassbi, Mehdi Hosseinzade, Keivan Navi	397
Parallel Fault Simulation Using Verilog PLI Mohammad Saeed Jahangiry, Sara Karamati, Zainalabedin Navabi	401
IEEE 1500 Compliant Test Wrapper Generation Tool for VHDL Models Sergey Mikhtonyuk, Maksim Davydov, Roman Hwang, Dmitry Shcherbin	406
Early Detection of Potentially Non-synchronized CDC Paths Using Structural Analysis Technique Dmitry Melnik, Olga Lukashenko, Sergey Zaychenko	411
An Editor for Assisted Translation of Italian Sign Language Nadereh Hatami, Paolo Prinetto, Gabriele Tiotto	415
Architecture Design and Technical Methodology for Bus Testing M.H. Haghbayan, Z. Navabi	419
Assertion Based Verification in TLM AmirAli Ghofrani, Fatemeh Javaheri, Zainalabedin Navabi	424
Flash-memories in Space Applications: Trends and Challenges Maurizio Caramia, Stefano Di Carlo, Michele Fabiano, Paolo Prinetto	429
Design Experience with TLM-2.0 Standard: A Case Study of the IP Lookup LC-trie Application of Network Processor Masoomeh Hashemi, Mahshid Sedghi, Morteza Analoui, Zainalabedin Navabi	433
Test Strategy in OSCI TLM-2.0 Mina Zolfy, Masoomeh Hashemi, Mahshid Sedghi, Zainalabedin Navabi and Ziaeddin Daeikozekanani	438
Synthesizing TLM-2.0 Communication Interfaces Nadereh Hatami, Paolo Prinetto	442

Advanced Topics of FSM Design Using FPGA Educational Boards and Web-Based Tools Alexander Sudnitson, Dmitri Mihhailov, and Margus Kruus	446
A Mixed HDL/PLI Test Package Nastaran Nemati, Majid Namaki-Shoushtari, Zainalabedin Navabi	450
Testing Methodologies on Communication Networks Nadereh Hatami, Paolo Prinetto, Gabriele Tiotto, Paola Elia	456
A Novel High Speed Residue to Binary Converter Design Based on the Three-Moduli Set $\{2n, 2n+1+1, 2n+1-1\}$ Muhammad Mehdi Lotfinejad, Mohammad Mosleh and Hamid Noori	460
Performance Evaluation of SAT-Based ATPG on Multi-Core Architectures Alejandro Czutro, Bernd Becker, Ilija Poljan	463
Intelligent Testbench Automation and Requirements Tracking Ivan Selivanov, Alexey Rabovoluk	471
Iterative Sectioning of High Dimensional Banded Matrices Dmytro Fedasyuk, Pavlo Serdyuk, Yuriy Semchyshyn	476
Estimating Time Characteristics of Parallel Applications in Technology of Orders Based Transparent Parallelizing Vitalij Pavlenko, Viktor Burdeinyi	480
Phase Pictures Properties of Technical Diagnostics Complex Objects Tverdokhlebov V.A.	483
Information Technology of Images Compression in Infocommunication Systems Alexander Yudin, Natalie Gulak, Natalie Korolyova	486
Technology of Cascade Structural Decoding Leonid Soroka, Vladimir Barannik, Anna Hahanova	490
Technology of the Data Processing on the Basis of Adaptive Spectral- Frequency Transformation of Multiadical Presentation of Images Vladimir Barannik, Sergey Sidchenko, Dmitriy Vasiliev	495
Compression Apertures Method - Color Different Images Konstantin Vasyuta, Dmitry Kalashnik, Stanislav Nikitchenko	499
Isotopic Levels Architectural Presentation of Images Relief Vladimir Barannik, Alexander Slobodyanyuk	502
Method and Mean of Computer's Memory Reliable Work Monitoring Utkina T.Yu., Ryabtsev V.G.	505
Extended Complete Switch as Ideal System Network Mikhail F. Karavay and Victor S. Podlazov	513
Image Compression: Comparative Analysis of Basic Algorithms Yevgeniya Sulema, Samira Ebrahimi Kahou	517
Networked VLSI and MEMS Designer for GRID Petrenko A.I.	521
Path Delay Fault Classification Based on ENF Analysis Matrosova A., Nikolaeva E.	526
COMPAS – Advanced Test Compressor Jiří Jeníček, Ondřej Novák	532
INVITED TALKS	538
AUTHORS INDEX	545

Technology of Cascade Structural Decoding

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Abstract

The necessity of increase of operationability of renewal of information is grounded without errors in the systems of digital diagnostics. Proof of theorem is conducted about decoding of code-number of cascade structural number. As a result of the well-proven theorem correlations are built providing renewal of elements of binary cascade structural number for the set official information without bringing of errors. The basic stages of process are expounded renewals of binary information on the basis of the cascade structural decoding, plugging in itself the system of expressions for recurrent determination of value of initial gravimetric coefficient of column of cascade structural number. Technology of rapid renewal of elements of cascade structural number is built without implementation of decodings actions.

Keywords – cascade structural numbers, of coda-number of column of binary array.

1. Introduction

For the increase of operationability of communication of data in the informatively-telecommunication systems it is necessary to carry out their compact presentation [1, 2]. It results in diminishing of digital volumes of information, and consequently, and to diminishing of amount of packages of information. Important requirements to the methods of compression it is been: increase of degree of compression; providing of control of the errors given without bringing; decline of time of treatment. Thus in a number of practical applications, in that numbers in the process of diagnostics of digital charts, it is especially important to carry out rapid renewal of information. For existent approaches in organization of compression and renewal of binary information the additional increase of coefficient of compression is or

with the loss of information or with the increase of temporal expenses on treatment [1 - 4]. From here **the scientifically-applied task** is a decline of time of renewal of information at the maintenance of the required level of authenticity of information.

The method of compact presentation of binary information is in-process [5] developed with arbitrary statistical descriptions. It is rotined that approach, based on forming of cascade structural code combinations, allows to promote the degree of compression. In also time for the use of this method in the handling systems of data it is required to carry out their timely renewal without bringing of errors. Means **the purpose of researches** is in developments of method of rapid renewal of cascade structural numbers (CSN) without bringing of error.

2. Development of method of decoding of cascade structural code constructions

We will consider sending for the decline of amount of operations to renewal of binary information without bringing of error. We will rosin at the beginning, that by value koda-number $C_{\Psi}^{(2)}$ and for the known official information it is possible without bringing of error to recover an initial cascade structural number G .

For this purpose we will formulate and will prove a next theorem.

Theorem about renewal of cascade structural numbers. *Binary sequence* $G = \{g_{k\ell}\}$, $k = \overline{1, n}$,

$\ell = \overline{1, n}$, satisfying limitations:

$$G^{(\ell)} = \{g_{k\ell}\}_{k=\overline{1, n}} \rightarrow \eta_{\ell};$$

$$C_{\ell} < F(\eta, \lambda)_{\ell} = \min(V_{\ell, \nu, \eta}; \lambda_{\ell}), \ell = \overline{1, n},$$

(where C_{ℓ} - value of coda-number of column of binary array) it is possible will recover without bringing an error on the basis of values of coda-

number $C_{\Psi}^{(2)}$, taking into account the known values of sizes: length of binary columns, vector of limitations $F = \{F(\eta, \lambda)_{\ell}\}_{\ell=1, \overline{n}}$ on the ranges of codas of one-dimensional floating structural numbers and vector $\{\eta_1, \dots, \eta_{\ell}, \dots, \eta_n\}$ limits on the number of cereus of units in binary columns, by system of expressions:

$$g_{k\ell}^{(\Psi)} = \text{sign}(1 + \text{sign}(C(k-1; \ell)_{\Psi}^{(2)} - \phi_{k\ell})), k = \overline{1, n}, \ell = \overline{1, n}; \quad (1)$$

$$\phi_{0\ell} = \frac{(n)!}{(2\eta)!(n-2\eta)!} \left(\prod_{g=\ell+1}^n F(\eta, \lambda)_g \right) \quad (2)$$

$$F(\eta, \lambda)_{\ell} = \begin{cases} \lambda_{\ell}, & \rightarrow \lambda_{\ell} < V_{\ell, v, \eta}; \\ V_{\ell, v, \eta}, & \rightarrow \lambda_{\ell} \geq V_{\ell, v, \eta}. \end{cases} \quad (3)$$

- if $g_{k-2, \ell} = 1$, and $g_{k-1, \ell} = 0$, and also if $|g_{k-2, \ell} - g_{k-1, \ell}| = 0$ and $(g_{k-2, \ell} - g_{k-1, \ell}) = 0$, to $\phi_{k\ell} = \phi_{k-1, \ell} (n-k+1-t_{k-1, \ell}+1) / (n-k+2)$; (4)
- if $g_{k-2, \ell} = 0$, and $g_{k-1, \ell} = 1$, to

$$\phi_{k\ell} = \frac{\phi_{k-1, \ell} \prod_{\gamma=1}^2 (t_{k-1, \ell} + \gamma)}{(n-k+1-t_{k-1, \ell})(n-k+2)}, \quad (5)$$

where $g_{k\ell}^{(\Psi)}$ - $(k; \ell)$ element Ψ cascade structural number; $\phi_{k\ell}$ - amount of cascade binary structures $G_k^{(\ell)}$, at which $(k; \ell)$ an element is equal to the zero, I.e. $g_{k\ell}^{(\Psi)} = 0$; $t_{k-1, \ell}$ - a parameter reflecting dependence of amount of units, forming the number of cereus of units on the current stage of treatment. Calculated on basis recurrent correlations

$$t_{k, \ell} = t_{k-1, \ell} - \left| g_{k-1, \ell}^{(\Psi)} - g_{k\ell}^{(\Psi)} \right| + (g_{k-1, \ell}^{(\Psi)} - g_{k\ell}^{(\Psi)}), t_{0, \ell} = 2\eta_{\ell}; \quad (6)$$

$C(k-1; \ell)_{\Psi}^{(2)}$ - remaining value of coda-number $C_{\Psi}^{(2)}$, got for a binary structure $G_k^{(\ell)}$, consisting of $((n-k+1) + n(n-\ell))$ binary elements:

$$G_k^{(\ell)} = \{g_{k, \ell}^{(\Psi)}, \dots, g_{n, \ell}^{(\Psi)}, g_{1, \ell+1}^{(\Psi)}, \dots, g_{n, \ell+1}^{(\Psi)}, \dots, g_{1, n}^{(\Psi)}, \dots, g_{n, n}^{(\Psi)}\}; \quad (7)$$

$$C(k; \ell)_{\Psi}^{(2)} = C(k-1; \ell)_{\Psi}^{(2)} - g_{k\ell}^{(\Psi)} \phi_{k\ell}, C(0; 1)_{\Psi}^{(2)} = C_{\Psi}^{(2)}; \quad (8)$$

$$C(1; \ell)_{\Psi}^{(2)} = C(n; \ell-1)_{\Psi}^{(2)};$$

$C(1; \ell)_{\Psi}^{(2)}$, $C(n; \ell-1)_{\Psi}^{(2)}$ - remaining values of coda-number are accordingly for the first element ℓ column and last element $(\ell-1)$ column of CSN

Proof. Gravimetric coefficient of element $g_{k\ell}^{(\Psi)}$ cascade structural number (CSN) consists of two factors and equal $p_{k\ell}^{(\Psi)} \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi}$.

On the basis of features the construction of possible great number of floating structural numbers flows out, that factor $p_{k\ell}^{(\Psi)}$ possesses the followings properties:

- for the single value of element ($g_{k\ell}^{(\Psi)} = 1$) CSN size $p_{k\ell}^{(\Psi)}$ equal to the amount of preceding the current number of possible OFPSN, at which on k positions are located zero elements;

- size $p_{k\ell}^{(\Psi)}$ in supposition, that k an element is equal to the zero ($g_{k\ell}^{(\Psi)} = 0$) it is on a formula

$$p(g_{k\ell}^{(\Psi)} = 0) = (n-k+1)! / ((t_{k-1, \ell})!(n-k+1-t_{k-1, \ell})!); \quad (9)$$

- on condition of equality of refurbishable element 1, I.e. $g_{k\ell}^{(\Psi)} = 1$, equality is executed

$$p_{k\ell}^{(\Psi)} \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi} = \phi_{k\ell}. \quad (10)$$

From here governed for renewal of elements of CSN it is suggested to build on the basis of the first two terms. If a refurbishable element will be equal to 1, $g_{k\ell}^{(\Psi)} = 1$, remaining value of coda-number

$C(k-1; \ell)_{\Psi}^{(2)}$ it will be anymore or equal amounts of possible OFPSN, preceding a current number, but value k element at which equal to the zero

$$C(k-1; \ell)_{\Psi}^{(2)} \geq p(g_{k\ell}^{(\Psi)} = 0) \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi} \text{ for } g_{k\ell}^{(\Psi)} = 1. \quad (11)$$

In reverse case, when a refurbishable element is equal to the zero, $g_{k\ell}^{(\Psi)} = 0$, then remaining value of coda-number $C(k-1; \ell)_{\Psi}^{(2)}$ there will be a less total amount of contiguous possible CSN, at which value k element at which equal to the zero

$$C(k-1; \ell)_{\Psi}^{(2)} < p(g_{k\ell}^{(\Psi)} = 0) \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi} \text{ for } g_{k\ell}^{(\Psi)} = 0. \quad (12)$$

From the analysis of correlations (11) (12) follows, that:

- for the calculation of sizes $C(k-1; \ell)_{\Psi}^{(2)}$ and $p(g_{k\ell}^{(\Psi)} = 0)$ it is not required to know a value k element of refurbishable element;

- result of comparison of sizes $C(k-1; \ell)_{\Psi}^{(2)}$ and $p(g_{k\ell}^{(\Psi)} = 0)$ there is identical in relation to the value of refurbishable element.

Consequently, sizes $C(k-1; \ell)_{\Psi}^{(2)}$ and can be utilized for determination of value of element $g_{k\ell}^{(\Psi)}$.

Governed for renewal of elements of CSN looks like

$$\begin{cases} g_{k\ell}^{(\Psi)} = 0, \rightarrow C(k-1; \ell)_{\Psi}^{(2)} < p(g_{k\ell}^{(\Psi)} = 0) \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi}; \\ a_{izj} = 1, \rightarrow C(k-1; \ell)_{\Psi}^{(2)} \geq p(g_{k\ell}^{(\Psi)} = 0) \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi}. \end{cases} \quad (13)$$

Replacing a size in right parts of inequalities of the system (13) $p(g_{k\ell}^{(\Psi)} = 0) \prod_{\phi=\ell+1}^n F(\eta, \lambda)_{\phi}$ by expression

(10), will get

$$\begin{cases} g_{k\ell}^{(\Psi)} = 0, \rightarrow C(k-1; \ell)_{\Psi}^{(2)} < \phi_{k\ell}; \\ g_{k\ell}^{(\Psi)} = 1, \rightarrow C(k-1; \ell)_{\Psi}^{(2)} \geq \phi_{k\ell}. \end{cases} \quad (14)$$

We will replace two operations of comparison of sizes $C(k-1; \ell)_{\Psi}^{(2)}$ and $\phi_{k\ell}$ on the operation of verification of difference between these sizes. These actions are set an operator $\text{sign}(u)$.

Taking into account this operator the set of inequalities (14) will assume an air of correlation (1).

Third property of gravimetric coefficient, set a formula (10) allows to count the remaining value of coda-number. Indeed, as on the value of coda-number the single elements of CSN influence only, at knowledge of their gravimetric coefficient the remaining value of coda-number will be determined on correlation (8). A theorem about renewal is well-proven.

As a result of the well-proven theorem correlations are built providing identical renewal of elements of binary cascade structural number for the set official

information (a number of cereus of units is in the columns of CSN, limit on the values of codas-numbers of OFPSN).

For diminishing of amount of operations of the initial parameter expended on a calculation $\phi_{0\ell}$ it is suggested to conduct his calculation on the basis of size ϕ_{01} - found for the first column of cascade structural number. For this purpose it is required to set interdependence between sizes $\phi_{0\ell}$ and ϕ_{01} . Size ϕ_{01} for the known values of length of column n and numbers of cereus of units η_0 equal

$$\phi_{01} = (n)! / ((2\eta_0)! (n-2\eta_0)!). \quad (15)$$

From other side size $\phi_{0\ell}$ for the known sizes n and η_{ℓ} it is on a formula

$$\phi_{0\ell} = (n)! / ((2\eta_{\ell})! (n-2\eta_{\ell})!). \quad (16)$$

As expressions (15) and (16) differ denominators, the followings variants are possible:

- if between sizes η_0 and η_{ℓ} inequality is executed $\eta_0 < \eta_{\ell}$, to

$$\phi_{0\ell} = \phi_{01} \frac{\prod_{k=n-2\eta_{\ell}+1}^{n-2\eta_0} k!}{\prod_{k=\eta_0+1}^{\eta_{\ell}} k!}; \quad (17)$$

- otherwise for $\eta_0 > \eta_{\ell}$, it will be

$$\phi_{0\ell} = \phi_{01} \frac{\prod_{k=\eta_0+1}^{\eta_{\ell}} k!}{\prod_{k=n-2\eta_{\ell}+1}^{n-2\eta_0} k!}; \quad (18)$$

- for a condition $\eta_0 = \eta_{\ell}$ equality corresponds $\phi_{0\ell} = \phi_{01}$.

Correlations (17) and (18) allow to eliminate a necessity for the calculation of factorial expressions on the basis of the use of the known information about the initial parameter of process of renewal for the first column of cascade structural number.

For additional reduction of amount of operations it is suggested to take into account possibility of operative renewal of elements of cascade structural number.

Determination 1. Under operative renewal of elements of binary sequence possibility of determination of values of the got elements is understood without the leadthrough of decoding actions.

In this connection we will formulate and will prove next consequences.

Investigation 1. If on k step of decoding between by a size $t_{k,\ell}$ and by the amount of the unrecovered elements $(n-k+1)$ equality is executed

$$t_{k,\ell} = (n-k+1), \quad (19)$$

values of elements $g_{u\ell}^{(\psi)}$, where $u = \overline{k, n}$ will be equal:

- for $k=0$:

$$g_{2\xi, \ell}^{(\psi)} = 0, \xi = \overline{1, \lfloor n/2 \rfloor}; \quad g_{2\xi+1, \ell}^{(\psi)} = 1, \xi = \overline{0, \lfloor n/2 \rfloor}; \quad (20)$$

- for $k \geq 1$:

$$g_{k+2\xi, \ell}^{(\psi)} = 0, \xi = \overline{0, (\lfloor n/2 \rfloor - 1)}; \\ g_{k+2\xi+1, \ell}^{(\psi)} = 1, \xi = \overline{0, (\lfloor n/2 \rfloor - 1)}; \quad (21)$$

Proof. We will consider a variant, when index of refurbishable element more zero. It is necessary on the basis of expression (6), that size $t_{k, \ell}$ can take on only even values. Indeed between sizes $t_{k, \ell}$ and $t_{k-1, \ell}$ can be executed the followings correlations:

$$t_{k, \ell} = \begin{cases} t_{k-1, \ell}, & \rightarrow g_{k\ell}^{(\psi)} = 0 \ \& \ (g_{k-1, \ell}^{(\psi)} = 1; g_{k\ell}^{(\psi)} = 1); \\ t_{k-1, \ell} - 2, & \rightarrow (g_{k-1, \ell}^{(\psi)} = 0; g_{k\ell}^{(\psi)} = 1). \end{cases} \quad (22)$$

As an initial value of size $t_{k, \ell}$ it is even (on determination of cascade structural numbers), on the basis of correlation (22) all subsequent values of sizes $t_{k, \ell}$ also will be even. A size means $t_{k, \ell}$ specifies on that how many whole cereus of units contained in $(n-k+1)$ not recovered elements. Consequently, if on k step of decoding a condition (19) is executed, and value of element $g_{k\ell}^{(\psi)} = 0$, : in $(n-k)$ elements there is a whole amount of cereus of units, equal $t_{k, \ell}$. But to make from $(n-k)$ elements number of cereus, equal $t_{k, \ell}$ there must be alternation of zeros and units, I.e. a condition must be executed (21).

Variant when index $k=0$ corresponds a case when the volume of possible great number of CSN is equal to 1. In this case the first element of refurbishable sequence will be equal to the zero. Investigation 1 it is well-proven.

Investigation 2. In case if gravimetric coefficient $\phi_{k\ell}$ element $g_{k\ell}^{(\psi)}$ equal to the zero, I.e. $\phi_{k\ell} = 0$, all the subsequent not recovered elements will be equal to 1, I.e. $g_{u\ell}^{(\psi)} = 1$, where $u = \overline{k, n}$.

Proof. As a gravimetric coefficient of element $g_{k\ell}^{(\psi)}$ to the zero, on the basis of expressions (5) and (6) will be equal to the zero coefficients of all of the not

recovered elements, I.e. $\phi_{u\ell} = 0$, where $u = \overline{k, n}$. It is necessary from here, that for any value of remaining coda-number $C(k-1; \ell)_{\psi}^{(2)}$ inequality will be executed $C(k-1; \ell)_{\psi}^{(2)} \geq \phi_{u\ell} = 0$, where $u = \overline{k, n}$. In also on the basis of correlation (1) get time $g_{u\ell}^{(\psi)} = 1$, where $u = \overline{k, n}$. *Investigation 2 it is well-proven.*

Means it is possible to do the followings conclusions:

1) identical renewal of cascade structural binary numbers is developed without the use of additional official information. The built decoding is based on the consistently-recurrent receipt of gravimetric coefficients of elements of CSN;

2) for the decline of amount of operations on renewal of binary elements technology of operative renewal of binary elements is created without implementation of decoding actions. This technology plugs in itself the systems of terms, taking into account dependences of parameters of process of decoding from maintenance of the not recovered elements and feature of forming of possible great number for the maximal values of number of cereus of units. It allows:

- to pre-ordain the values of all of the not recovered elements of CSN;

- exceptions are an amount of operations of increase and division, gravimetric coefficients of value of which required on a calculation 0 is scierter equal;

- exceptions are an amount of operations of increases and division, elements of CSN, the values of which are scierter equal to 1., taken on determination

3. Conclusion

Methodological bases are developed renewals of diagnostic information on the basis of the cascade structural decoding, pluggings in itself:

1. Proof of theorem about decoding of coda-number of cascade structural number. As a result of the well-proven theorem correlations are built providing non error renewal of elements of binary cascade structural number for the set official information (a number of cereus of units is in the columns of CSN, limit on the values of codas-numbers of OPSN).

2. Method of operative renewal of elements of cascade structural number without implementation of decoding actions. This method plugs in itself the systems of terms, taking into account dependences of parameters of process of decoding from maintenance of the not recovered elements and feature of forming of possible great number for the maximal values of number of cereus of units. It allows: to pre-ordain the

values of all of the not recovered elements of CSN; exceptions are an amount of operations of increase and division, gravimetric coefficients of value of which required on a calculation 0 is scatter equal; exceptions are an amount of operations of increases and division, elements of CSN, the values of which are scatter equal to 1., taken on determination.

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Approved for publication: 31.08.2009. Format 60×84¹/₈.
Relative printer's sheets: . Circulation: 150 copies.
Published by SPD FL Stepanov V.V.
Ukraine, 61168, Kharkov, Ak. Pavlova st., 311

Матеріали симпозиуму «Схід-Захід Проектування та Діагностування – 2009»
Макет підготовлено у Харківському національному університеті радіоелектроніки
Редактори: Володимир Хаханов, Світлана Чумаченко
Пр. Леніна, 14, ХНУРЕ, Харків, 61166, Україна

Підписано до публікації: 31.08.2009. Формат 60×84¹/₈.
Умов. друк. арк. . Тираж: 150 прим.
Видано: СПД ФЛ Степанов В.В.
Вул. Ак. Павлова, 311, Харків, 61168, Україна